Final

2016 Quality Assurance Project Plan

East Harbor Operable Unit

Wyckoff/Eagle Harbor Superfund Site

January 9, 2017

Prepared for:

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Title and Approval Sheet

2016 Quality Assurance Project Plan, Monitoring Year 22, East Harbor Operable Unit, Wyckoff/Eagle Harbor Superfund Site

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Acronym List

ADR	Automated Data Review
AQAP	Analytical Quality Assurance Plan
ARI	Analytical Resources Incorporated
ASTM	American Society for Testing and Materials
C	Celsius
CAS	Chemical Abstract System
CCS	Contract Compliance Screening
CLP	Contract Laboratory Program
CFR	Code of Federal Regulations
CG/MS	Gas Chromatography/Mass Spectroscopy
CLP	Contract Laboratory Program
CMS	Coastal Modeling System
CoC	Chain-of-Custody
COC	Chemical of Concern
CPR	Cardio Pulmonary Resuscitation
CSL	Cleanup Screening Level
CSM	Conceptual Site Model
CVAAS	Cold Vapor Atomic Absorption Spectrum
DGPS	Differential Global Positioning System
DI	Distilled water
DoD	Department of Defense
DQI	Data Quality Indicators
DQO	Data Quality Objectives
DQSR	Data Quality Summary Report
DVR	Data Validation Report
EBS	Exposure Barrier System
EDD	Electronic Data Deliverable
EHOU	Eagle Harbor Operable Unit
EIM	Environmental Information Management
EPA	Environmental Protection Agency
EQuIS	Environmental Quality Information System
FSP	Field Sampling Plan
GC	Gas Chromatography
GC/ECD	Gas Chromatography/Electron Capture Device
gINT	Geotechnical Integrator
GPC	Gel Permeated Chromatography
GPS	Global Positioning System
HAZWOPER	Hazardous Waste Site Operations Training
HDPE	High Density Polyethylene

HDR	HDR Engineering, Inc.
HSP	Health and Safety Plan
ICP	Inductively Coupled Plasma
ICP/AES	Inductively Coupled Plasma/Atomic Emission Spectroscopy
IDWP	Investigation Derived Waste Plan
KTA	Ken Taylor Associates, Inc.
LAET	Lowest Apparent Effects Threshold
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LIMS	Laboratory Information Management System
LOD	Limits of Detection
LOQ	Limits of Quantitation
LVI	Large Volume Injection
MCA	Miller Creek Aerial Mapping
MCLU	Minimum Cleanup Level
MDL	Method Detection Level
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
MRL	Method reporting Level
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MSL	Mean Sea Level
MSS	Marine Sampling Services
NAD	North American Datum
NAPL	Non-Aqueous Phase Liquid
NIST	National Institute of Standards and Technology
NTCRA	Non-Time Critical Removal Action
OMMP	Operations, Maintenance, and Monitoring Plan
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
PC	Personal Computer
PCB	Polychlorinated Biphenyl
PCP	Pentachlorophenol
PID	Photo Ionization Detector
PMP	Project Management Plan
PPE	Personal Protective Equipment
PSEP	Puget Sound Estuary Program
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QSM	Quality System Manual for Environmental Laboratories

ROD	Record of Decision
RPD	Relative Percent Difference
SEDD	Staged Electronic Data Deliverable
SEE	Science and Engineering for the Environment, LLC
SIM	Selective Ion Monitoring
SMS	Sediment Management Standards
SOP	Standard Operating Procedure
SOW	Scope of Work
SQS	Sediment Quality Standard
SRM	Standard Reference Material
SVOC	Semi-volatile Organic Compound
TOC	Total Organic Carbon
TSD	Treatment, Storage and Disposal
UE	Ultrasonic Extraction
USACE	US Army Corps of Engineers
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife

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1.0 Project Management Elements

1.1 Introduction

This Quality Assurance Project Plan (QAPP) provides specific guidance for field and quality assurance procedures that will be followed by HDR Engineering, Inc. (HDR), and Science and Engineering for the Environment, LLC (SEE), and their subcontractors, during Year 22 monitoring and implementation of the 2016 Operations Maintenance and Monitoring Plan (OMMP) Addendum (USACE 2016). HDR is the prime contractor conducting this work under contract to the U.S. Army Corps of Engineers (USACE), Seattle District, with direction from USACE and the U.S. Environmental Protection Agency (EPA), Region 10. The QAPP is specifically limited to field activities during Year 22 monitoring studies of the East Harbor Operable Unit (EHOU) and responds to the scope of work (SOW) dated 24 October 2016 titled “Wyckoff/Eagle Harbor East Harbor OU OMMP Implementation." The 2016 Work Plan replaces the 2011 Work Plan; however, portions of the 2011 Work Plan detailing sampling methodologies are carried forward by reference.

The work conducted under this QAPP will guide the monitoring that will be carried out in this 22nd year of monitoring at the EHOU (hereafter referred to as “Year 22 monitoring”). The 2016 OMMP Addendum (USACE 2016) is the Work Plan for Year 22 monitoring, and provides the framework for the QAPP. The results of the Year 22 monitoring will be analyzed and interpreted in the 2016 Wyckoff/Eagle Harbor EHOU Monitoring Report. EPA will use the Monitoring Report in support of the Five Year Review required in 2017.

This document is the Project Management Plan (PMP) component of the QAPP. The PMP details the component documents that collectively comprise the overall plan for work during the Year 22 monitoring; organization of the project team; problem definition and site objectives; data reduction, management, and reporting procedures; and the overall project schedule.

1.2 Distribution List

Signees and those people listed in Table PMP-1 (distribution list) will receive a copy of this QAPP and its components, as well as the Work Plan (2016 OMMP Addendum), Health and Safety Plan (HSP), and Investigation-Derived Waste Plan (IDWP). The contract project manager will provide official copies and any subsequent revisions to the individuals on the distribution list.

1.3 Project Organization

Project organization and individuals responsible for ensuring the quality of field operations, data collections, and laboratory procedures for the Year 22 monitoring are provided in Table PMP-2 along with their responsibilities. The organizational chart is presented in Figure PMP-1.

1.4 Components of the Work Plan

This document, the QAPP is one component of the Year 22 Monitoring Work Plan that implements the 2016 OMMP Addendum. The Year 22 Work Plan and this PMP are updates of the 2011 Year 17 OMMP Work Plan (HDR and SEE 2011) and supporting documents. The 2016 OMMP Addendum describes changes to sections of the 1995, 1999, 2002, and 2011 Work Plans, and references those plans where changes have not occurred. This revised document also contains new information relevant to monitoring of the intertidal areas surrounding the site (i.e., West Beach, including the exposure barrier system [EBS] and intertidal cap) depicted in Figure FSP-3).

This QAPP is written to meet the function requirements from the EPA *Guidance for Quality Assurance Project Plans* (EPA 2002). The five documents listed below comprise the Year 22 EHOU Monitoring Work Plan:

Quality Assurance Project Plan. The overall plan for monitoring including objectives, monitoring plan design, measurement methods (types of data to be collected), schedule, deliverables, use of monitoring results in site management, the project team, and project responsibilities. The QAPP has three primary components including the: PMP, Field Sampling Plan (FSP), and Analytical Quality Assurance Project Plan (AQAP). The IDW and HSP are also prepared to supporting implementation of the SOW outlined in the QAPP and associated documents.

Project Management Plan. The PMP is the bridge document for the QAPP. In addition to providing the overall project organization and personnel responsibilities (Section 1.2), the PMP provides the program elements common to the field and analytical monitoring including site information and history, monitoring objectives of the 2016 OMMP Addendum, personnel training requirements, data management, reporting requirements, and an overall schedule for completion of the monitoring and reporting.

Field Sampling Plan. The FSP describes the field procedures and detailed activities including physical elevation monitoring, surface sediment and West Beach samples for chemical analyses, and subsurface samples for quality interpretation. The FSP addresses sample analyses procedures only from sample collection up to delivery to the analytical laboratories or data reduction locations.

Analytical Quality Assurance Project Plan. The AQAP provides the details of field sampling and analytical procedures that will be followed so that the environmental data are of known and documented quality and suitable for their intended uses, and the environmental data collection and technology programs meet stated requirements. It will include the data quality objectives of sample collection, numbers and types of stations to be sampled for each data type, field procedures, and instrumentation. The chemical analysis component includes detailed direction to the analytical laboratory on analytical methods, data quality objectives, sample custody, quality assurance and quality control (QA/QC) procedures, data deliverables, data management, and reporting. The AQAP is provided to office personnel and the analytical laboratory.

Investigation-Derived Waste Plan. The IDWP details the handling procedures, containerization, and disposal of investigation-derived wastes generated during the monitoring program, including decontamination products, excess sample material, and personal protective equipment.

Health and Safety Plan. The HSP describes the procedures and equipment that will be used to protect the health and safety of project staff and the public during monitoring. The HSP identifies chemical and physical hazards, types of work zones, protective equipment and procedures, responsible individuals, and an emergency plan.

1.5 Site Terminology

Throughout this document specific terms will be used to reference the study areas within the EHOU. Figures FSP-2 and FSP-3 show the areas of the EHOU that have been remediated along with the extent of individual removal actions or remedial activities. Below are the definitions of specific terminology for each action and study area for the EHOU.

1994 Phase I Subtidal Cap. The 1994 Phase I subtidal cap was placed in 1994-1995 as part of a Non-Time-Critical Removal Action (NTCRA). This NTCRA consisted of placement of an approximately 1 meter (m) (3 feet [ft]) thick sediment cap over 21.4 hectares of subtidal sediments. Figure FSP-2 depicts the extent of the 1994 Phase I sediment cap.

2000 Phase II Subtidal Cap. Figure FSP-2 shows the 2000 Phase II subtidal cap, which was placed to augment the 1994 Phase I cap. The 2000 Phase II cap overlaps the Phase I cap at its southern boundary, and covers uncapped shallow subtidal sediments not previously capped during the 1994 NTCRA. In the area where the 2000 cap overlaps the 1994 NTCRA, cap materials were placed to cover surface sediments with polycyclic aromatic hydrocarbon (PAH) concentrations that were above the Washington State Sediment Quality Standards (SQS), as reported in the 1999 Year 5 monitoring results.

2001 Phase III Subtidal Cap. The 2001 Phase III cap extends shoreward from the 2000 Phase II cap. It overlaps both the 1994 Phase I and 2000 Phase II caps. It was placed atop of uncapped shallow subtidal sediments and intertidal sediments. Figure FSP-2 shows the extent of the 2001 Phase III subtidal cap.

Exposure Barrier System (EBS). The EBS, completed in 2008, covers approximately 5.1 acres of intertidal and shallow subtidal sediments on West Beach. The location of the EBS is shown in Figures FSP-2 and FSP-3.

Intertidal Cap. The intertidal cap is the extension of the 2001 Phase III subtidal cap shoreward, covering the intertidal surface sediments where PAH concentrations exceeded the SQS. Figures FSP-2 and FSP-3 depict this cap.

North Shoal. The North Shoal consists of the intertidal area on the north shore of the former Wyckoff facility. It is bounded to the west by the intertidal cap and to the east by East Beach. Figure FSP-3 shows the North Shoal area.

East Beach. East Beach consists of the intertidal area on the eastern side of the former Wyckoff facility. As depicted in Figure FSP-3, it is bounded to the north by the North Shoal and extends southward to the Wyckoff property boundary.

West Beach. West Beach (formerly known as the Mitigation Beach) lies at the western edge of the Wyckoff facility property boundary and encompasses both the EBS and the riparian habitat upland from the intertidal EBS. West Beach and the delineation of the EBS and the Intertidal Cap are shown in Figure FSP-3. The former Mitigation Beach was constructed in 2000 and 2001 with the areas above +17 ft mean lower low water (MLLW) vegetated to provide riparian habitat around the Wyckoff facility which, with the EBS, constitutes West Beach.

2.0 Problem Definition/Background

The Wyckoff/Eagle Harbor Superfund Site, EHOU is located on Bainbridge Island, Washington (Figure PMP-2). The Record of Decision (ROD) for this Operable Unit (OU) is dated September 24, 1994 (EPA 1994).

The EHOU OMMP was first developed in 1995 (EPA and USACE 1995) to support overall site management. The 1995 OMMP was implemented after completion of the first phases of remediation at the site (1994 – 1995) and was intended to guide monitoring related to remedy effectiveness and to provide additional information regarding potential additional remedial requirements. As site conditions have warranted and further remedial actions were implemented, the OMMP has been amended to account for the necessary changes in operations, monitoring, and management practices.

Monitoring studies conducted from 1994 to 2002 indicate that the 21.4-hectare sediment cap was largely functioning as intended by isolating underlying contaminated sediments and providing suitable habitat for benthic organisms. Since 2002, additional remediation occurred in West Beach where PAH concentrations were found to be elevated relative to the Washington State Sediment Management Standards (SMS) [SQS or Minimum Cleanup Levels (MCUL)] (Ecology 1995). In other areas (i.e., East Beach, North Shoal), the progress of monitored natural recovery continues to be tracked, with a goal of achieving PAH levels below the MCUL in 10 years, subject to additional remedial actions at the site.

The 2016 OMMP Addendum (USACE 2016) is the fourth addendum to the 1995 OMMP. It presents the current state of knowledge; rationale for changes to the 1995, 1999, 2002, and 2011 OMMP Addenda objectives; and specific monitoring methods. The 2016 OMMP Addendum focuses monitoring objectives on areas remediated since the 2002 monitoring event. It presents the framework for monitoring to determine whether the implemented remedial actions are functioning as designed and provides the information necessary to guide and develop the work plan for monitoring to be carried out in Year 22 monitoring. West Beach and subtidal and intertidal areas of the EHOU will be monitored under this work plan. Biological surveys of bird, mammal, invertebrate, macroalgae, and forage fish species will not be conducted. The data gathered from the Year 22 monitoring will supply information to the EPA in support of the Five-Year Reviews required in 2017.

2.1 Site Chronology

A succession of companies treated wood and wood products from the early 1900s through 1988 at the Wyckoff site. Initially, treatment was accomplished by wrapping wood and poles with burlap and asphalt; however, by 1910 pressure treatment with creosote and bunker oil began. The Wyckoff treatment plant was one of the largest in the United States. Wood preservative and treatment operations included:

- The use and storage of creosote, pentachlorophenol, solvents, gasoline, antifreeze, fuel and waste oils, and lubricants
- Generation and management of process wastes
- Treatment and discharge of wastewaters
- Storage of treated wood and wood products

Little historical information exists about the waste management practices at the Wyckoff facility. Prior to its reconstruction in the 1920s, the facility was reported to have floated logs in and out of the lagoon that once existed at the Wyckoff facility. The lagoon was subsequently filled. Beginning in the 1940s, treated logs were also transported to and from the facility at the former West Dock via a transfer table pit, and the chemical solution drained from retorts after a treatment cycle went directly onto the ground and seeped into the soil and groundwater below. This process continued until operations ceased in 1988. Wastewater was also discharged into Eagle Harbor for an unknown number of years, and the practice of storing treated pilings and timber in the water continued until the late 1940s. Further introduction to the harbor of process and treatment-related products and wastes occurred during the period of facility operation and included drips, releases from handling, and spills.

Table PMP-3 provides a brief chronology of site events and activities that are pertinent to the EHOU intertidal and subtidal remedies. The chronology is adapted from the EPA's 5-Year review document (EPA 2002), previous site investigations, and the 2016 OMMP Addendum (USACE 2016).

2.2 Recent Site Activities

Relevant completed remedial actions in the EHOU include:

- Placement of a subtidal sediment cap completed in three phases between 1993 and 2002.
- Upland source control completed in February 2001 by installation of a sheet pile wall around the perimeter of the former process area.
- Construction of a mitigation beach (completed in 2002), including removal of 366 linear meters [1,200 linear feet] of bulkhead; excavation of approximately 40,000 cubic yards of upland sediments; and placement of 8,500 cubic yards of clean imported sand - creating approximately 0.8 hectares (2 acres) of intertidal beach habitat.
- Construction of the EBS including approximately 1,000 ft of West Beach and approximately 5.1 acres from the southern edge of the existing subtidal cap.
- Maintenance and repair of existing sediment cap (scheduled early 2017).

2.3 Project Description and Schedule for Year 22 Monitoring

The 2016 OMMP Addendum (USACE 2016) provides the monitoring objectives and the work to be completed in the Year 22 monitoring event. Figure PMP-2 provides a general site map for the Year 22 monitoring. Detailed site maps that support the overall program monitoring objectives are provided in the 2016 OMMP Addendum and in the FSP. The paragraphs below provide a brief overview of the planned monitoring efforts. More detailed descriptions of the monitoring are provided in the FSP.

Surveys will be used to compare current conditions to historical conditions at West Beach (i.e., the EBS), and support an evaluation of whether additional actions are needed if differences are significant. Surveys to be completed (by the consultant team) include the following elements:

- Field surveys
- Bathymetric surveys

- Airborne LIDAR and aerial imagery acquisition

Chemical analyses of subtidal, intertidal, and West Beach (i.e., EBS) sediment samples will be performed for PAHs, pentachlorophenol (PCP), mercury (subtidal sediment sampling only), and conventional parameters to assess current nature and extent of contamination and confirm whether or not the sediment and beach caps are isolating the chemicals of concern. The contractor team will obtain samples of the following sediment types for analysis:

- Composite surface sediment samples from the subtidal cap and North Shoal subtidal area
- Composite core sediment samples from the West Beach/EBS

Subsurface sediment cores will also be collected for visual evaluation of the presence of absence or non-aqueous phase liquid (NAPL); no chemical analysis will be conducted on the subsurface sediment core samples.

The planned project schedule by task is provided in Figure PMP-3. A detailed plan for sampling events in the EHOU is provided in the FSP.

2.4 Quality Objectives for Year 22 Monitoring

The project's monitoring and quality objectives for Year 22 monitoring are summarized in Table PMP-4. Components of monitoring include surveys; chemical analyses of PAH, PCP, mercury, and conventional parameter concentrations in surface sediments from the subtidal cap and North Shoal subtidal area; analyses of PAH, PCP, and conventional parameter concentrations from West Beach, and collection of subsurface sediment cores from the subtidal cap and North Shoal subtidal area for visual evaluation of the presence of NAPL.

Sediment data quality objectives are also defined by the Remedial Goals for the subtidal and intertidal sediments, as established in EPA's 2007 Explanation of Significant Difference (EPA 2007) are listed in Table PMP-5. In addition, some areas of the EHOU are evaluated against the Washington SMS, as defined in Chapter 173-204 of the Washington Administrative Code (WAC) (Ecology 1995). The SMS, which are listed in Table PMP-6, serve as data quality objectives for both subtidal and intertidal/beach sediment to be collected and evaluated as part of this program.

3.0 Special Training

The site-specific HSP describes the health and safety training requirements for the sampling event. All site personnel obtaining or processing sediment samples have met the Hazardous Waste Site Operations Training (HAZWOPER) and other requirements of 29 Code of Federal Regulations (CFR) 1910.120(e), including:

- Forty hours of initial off-site training or its recognized equivalent
- Eight hours of annual refresher training for all personnel (as required)
- Eight hours of supervisor training for personnel serving as sediment site health and safety officers
- Three days of work activity under the supervision of a trained and experienced supervisor
- Current certification in cardiopulmonary resuscitation (CPR) and first aid

The project health and safety officer will ensure that all personnel have met the required training. Training records for contract personnel conducting sediment sampling and core processing are located in Appendix E of the HSP.

4.0 Data Reduction, Validation, Management, and Reporting

Technical and managerial data will be collected as part of this project. Technical data from the field and laboratory will be combined and evaluated against the overall program monitoring objectives in Tables PMP-4 and PMP-6. Managerial data will consist principally of audit and inspection documentation. This information will be used to assess and verify the quality of the measurements taken during the EHOU monitoring and validate adherence to protocols (both field and laboratory) established for the project.

The following sections describe the generation, checking, management, and reporting of data from both field sampling and laboratory analysis.

4.1 Data Reduction

This section outlines the procedures for ensuring the correctness of the data reduction process. The procedures describe steps for verifying the accuracy of data reduction. Data will be reduced either manually on calculation sheets or electronically on preformatted printouts. The following responsibilities will be delegated in the data reduction process:

- Technical personnel will document and review their own work and are accountable for its correctness.
- Major calculations will receive both a method and an arithmetic check by an independent reviewer (or peer reviews). The reviewer will be accountable for the correctness of the checking process.
- An independent technical review will be conducted to ensure the consistency and defensibility of the concepts, methods, assumptions, and calculations. This will be scheduled by the HDR project manager and will include a spot check of manual data transcriptions performed during data reduction, analysis, and reporting. If errors are found, a more thorough review of the transcriptions will be scheduled by the project manager.
- The HDR project manager will be responsible for ensuring that data reduction is performed in a manner that produces quality data after review and approval of calculations.

4.1.1 Hand Calculations

Hand calculations will be recorded on numbered calculation sheets or notebooks and will be legible and in logical progression with sufficient descriptions. Major calculations will be checked by a scientist of professional level equal to or higher than that of the originator. After completing the check, the reviewer will sign and date the calculation sheet or notebook page immediately below the signature of the originator, as applicable. Both the originator and reviewer are responsible for the correctness of calculations. A calculation sheet or notebook will contain the following, at a minimum:

- Project title and brief description of the task
- Date performed and signature of person who performed the calculation
- Basis of calculation
- Assumptions made or inherent in the calculation

- Complete reference for each source of input data
- Methods used for calculations
- Results of calculations, clearly annotated

4.1.2 Computer Analyses

Computer analyses include the use of programs, models, and data management systems. For published software with existing documentation, test runs will be periodically performed to verify that the software is performing correctly. This will include both ADR.net software and EQuIS™ software used to manage field and analytical data.

Quality control measures will be documented as referenced in applicable procedures.

4.2 Field Data

4.2.1 Field Data Reduction

Field measurements and observations will be recorded in project logbooks, on field data forms, or on similar permanent records by field technicians. Field measurements include water depths, visual descriptions, instrument readings, and meteorological conditions. Field data will be recorded directly and legibly in field notebooks or on customized field forms (numbered), and all entries will be signed and dated. If entries must be changed, the change will not obscure the original entry. The correction will be signed and dated. Field data records will be organized into standard formats whenever possible and retained in permanent files.

Managerial documentation consists of the following types of information:

- Data processing and storage records
- Sample identification and chain-of-custody records
- Field changes and variances
- Document control, inventory, and filing records
- Quality assurance/quality control records
- Health and safety records
- Contract and project tracking records

The combined data records will be sufficiently detailed to provide a complete and accurate history of data gathering and results for future legal or administrative actions, if necessary.

4.2.2 Field Data Evaluation

Data will be verified by the HDR project manager and the sediment technical lead, who will review collected data to ensure that correct codes and units have been used. When the data are returned to the field office at the end of the work day, the sediment technical lead or a designated representative will review the data for representativeness, accuracy, and comparability with other data collected. The sediment technical lead will direct the field scientists to make necessary corrections to the record and initial them. The sediment technical lead will then sign the records to indicate that he/she has reviewed them. After data reduction into tables, the HDR project manager and the sediment technical lead will review data sets for anomalous values. Any inconsistencies discovered will be resolved by seeking clarification from the field personnel responsible for data collection.

Managerial and technical data will be verified by the HDR project manager for completeness. The HDR project QA officer will review selected field data and procedures during random site visits to ensure adherence to QA/QC procedures, as applicable to the scope of work. Whenever possible, peer review will also be incorporated into the data evaluation process in order to maximize consistency among field personnel. Data evaluation will be verified by a dated signature.

The purpose of data evaluation is to ensure that defensible and justifiable data are obtained by following the project's environmental measurement objectives listed below:

- The project FSP will be followed.
- Equipment and instruments will be properly calibrated and in working order in accordance with manufacture specifications.
- Samples will be collected according to procedures specified in the FSP and standard operation procedures (SOPs) on file at HDR and SEE.
- Sufficient sample volume will be collected to maintain sample integrity and conduct all required analyses.
- Samples will be properly preserved in accordance with the AQAP.
- Applicable blanks and field QC samples will be provided per the frequency listed in the AQAP.
- Complete chain-of-custody documentation will be kept throughout the duration of the monitoring effort, and copies will be included with each sample shipment.
- Field samples will arrive at the laboratory in good condition and within specified hold times and sample preservation methods.

The purpose of the evaluation process is to eliminate field data that are not collected or documented in accordance with specified protocols outlined in the AQAP and FSP. In some instances, the field data will be used only for approximation purposes. In all cases, evaluation of field data will be performed on two levels. First, field data will be verified at the time of collection by following the quality control checks outlined in the AQAP and FSP. Second, field data will be verified by the sediment technical lead, who will review the field data documentation to identify discrepancies or unclear entries. Field data documentation will be reviewed against the following criteria, as appropriate:

- Stated project objectives of the Work Plan
- Stated QA objectives of the QAPP
- Sample location and adherence to the FSP
- Field instrumentation and calibration
- Sample collection protocol, volume, and preservation
- Blanks collected and submitted at the required frequency
- Field duplicates collected and submitted at the required frequency

- Sample documentation protocols
- Chain-of-custody protocol
- Sample shipment

Descriptive statistics for completeness will be calculated and reported. Final data evaluation will be performed by the HDR project manager and sediment technical lead. Evaluation criteria and QC check results will be presented and discussed in the "Quality Assurance" section of the monitoring report.

4.2.3 Field Data Reporting

The type and format of technical data to be gathered during the monitoring program are detailed in the FSP. A detailed description of the type and format for technical reports to be produced during this project is presented in the PMP Section 4.4. In addition, technical reports will undergo a formal internal quality assurance review by knowledgeable senior technical reviewers.

4.3 Laboratory Data

4.3.1 Data Evaluation

Data generated by laboratory analysis of samples will be evaluated by reviewing data packages including the chain-of-custody. Three analytical levels for quality control are described that correspond to the data evaluation specifications in the AQAP: quality control by the laboratory, HDR’s data validation team, and by EPA. The purpose of the evaluation process is to eliminate unacceptable analytical data and to designate a data qualifier for any data quality limitation discovered. In some instances, the analytical data may be used only for approximation purposes. Data evaluation summary reports will be filed with the data and will describe the usability of the data (i.e., the degree to which evaluated data are suitable for the purposes intended and whether the data are useful for other purposes).

ARI Data Review

To ensure that the final reported result is accurate and in the correct format, data will be reviewed by Analytical Resources, Incorporated (ARI), at the analytical, reporting, and approval levels. In addition, ARI's project manager performs a final, cursory review of the results prior to submission of the deliverable package. Electronic laboratory data will be provided in a format conforming to EQuIS Electronic Data Deliverable (EQEDD) and chemical data provided in ADR.net (A1/A3) format. The A1/A3 files will be checked using the ADR Contract Compliance Screening (CCS) by the laboratory. A detailed discussion of data reduction, reporting, and evaluation by ARI is presented in the laboratory QAPP on file at ARI.

HDR Data Quality Evaluation

Sediment samples collected during Year 22 monitoring will be reviewed and validated in accordance with EPA's guidelines for evaluating organics data (EPA 2008) and inorganics data (EPA 2010). If required, qualifiers will be applied to sample data as specified by EPA's functional guidelines (EPA 2008 and EPA 2010). Full chemical data validation (Stage 4) shall be conducted, at a minimum, on 10 percent of the PAH data, and a Stage 2B validation shall be completed for 100 percent of the PAH data. Data will be validated using ADR.net (most recent version).

Data quality evaluation and reporting will be accomplished by the HDR data QA officer for all data including conventional (i.e., total organic carbon [TOC] and contaminant analytes. Analytical data documentation will be evaluated against the following criteria, as appropriate:

- Chain-of-custody protocols and documentation
- Sample condition upon arrival at the analytical laboratory
- Analysis data versus applicable holding times
- Frequency of quality assurance and quality control analysis
- Laboratory blank contamination
- Calibration procedures and criteria
- Laboratory accuracy (percent recovery versus control limits)
- Laboratory precision (relative percent difference [RPD] versus control limits)
- Completeness.

USACE and EPA Data Review

The USACE and EPA will be responsible for the review, validation, and data management of the Year 22 biological tissue monitoring data. Biological tissue collection is being conducted by the USACE, with the tissue chemical analyses being completed by EPA's Manchester Laboratory. Input of the Year 22 biological tissue data into the overall Wyckoff/Eagle Harbor Superfund database will be the responsibility of the USACE and EPA.

4.3.2 Raw Data Management

An important part of the data record for the project is the availability of all raw laboratory data. The ability to recheck data accuracy will be important, and ultimately, the project record can only be complete if all data are maintained in an orderly, usable manner. ARI will be directed under contract terms to deliver raw data for all samples submitted. The HDR data QA officer, under the direction of the HDR project manager, will be the custodian for these electronic and hardcopy records. The HDR data QA officer will be responsible for providing the laboratory with specific electronic formats (e-QAPP) for each type of data, and with guidance for specific information required by the project.

4.4 Data Management and Reporting

The purpose of data management is to ensure the availability of complete, accurate, and valid data in an easily accessible and usable format. This section provides an overview of the methods and procedures that will be followed in the implementation of the data management plan as part of the EHOU monitoring. Proper data management will ensure the validity and accessibility of accurate data for environmental data analysis and evaluation.

4.4.1 Database Development

The database for the monitoring component of the EHOU OMMP will consist of evaluated data from environmental sampling conducted during the monitoring program and data from previous environmental sampling programs, as applicable, such as the Eagle Harbor preliminary investigation (Integral and USACE 2004, Tetra Tech 1986), the Remedial Investigation (CH2M Hill 1989), and the

Remedial Action (USACE 1994). The contractor will use EPA data validation guidelines and QC criteria specified in the AQAP to determine compliance with QC objectives. Data qualifier codes applied to the validated data will be consistent with EPA guidelines.

All evaluated data will be electronically stored as described in PMP Section 4.5. Queries can be made of the data using these programs, which screen for different analytical or environmental parameters. The HDR data manager will assist in developing database queries so that screenings can be conducted efficiently and rapidly. Also, once all data have been validated, data will be transmitted to the USACE in formats specified in the SOW dated 24 October 2016.

4.4.2 Data Entry, Quality Assurance, and Processing

All field data undergoing manual entry into EQuIS (or for boring logs entered first into gINT©) will be verified for accuracy by checking at least 10 percent of the data. Full chemical data validation (Stage 4) shall be conducted, at a minimum, on 10 percent of the PAH data, and a Stage 2B validation shall be completed for 100 percent of the PAH data. Validation of laboratory data will be conducted in ADR.net (most current version). Validation will include a review of the laboratory data to evaluate concentrations qualified as rejected values. Rejected values will not be deleted from the database. They are electronically flagged so that any queries conducted of the database will ignore the rejected values.

Field duplicates will also be evaluated. The order of priority for use of duplicate results to report as a single datum will be: primary sample result is greater than field duplicate result. The primary result will be used as the point estimation of concentration unless the primary value is rejected, in which case the field duplicate result will be used. The field duplicate result is not intended to represent a quantity but instead to provide independent checking on both field sampling techniques and laboratory analysis.

Once the above evaluation is complete, additional field QC samples are evaluated. These field QC samples include field blanks and equipment rinsates. A more detailed explanation of field QC is presented in the FSP. The steps for field blanks and equipment rinsate sample evaluation is as follows:

- All environmental samples are matched with associated field blanks and equipment rinsates.
- All potential contaminants detected in field blanks and equipment rinsates are evaluated and adjusted: concentrations are raised by a factor of 10, based on the detected compound and EPA validating procedures (EPA 2015 a,b).
- All concentrations in the associated environmental samples are then compared to the adjusted blank and rinsate results. If the environmental sample concentration does not exceed the blank or rinsate concentrations (10x), then the analyte is considered not detected at the concentration reported.

Once the field QC sample evaluation is complete, the following steps are followed to complete processing:

- Duplicate laboratory values from redundant analyses, reanalyses, and dilutions are evaluated and resolved.
- Field duplicate analyses are evaluated as stated above.

Following the completion of these steps, a value can be selected per parameter, sampling location, matrix, and day. However these QC values are used (e.g., average, maximum value), all data will be entered into the database and identified individually. The laboratory data will then be available for analysis.

Electronic uploading of data will be verified by using the ADR CCS and the EQuIS data processor to check for EQuIS requirements. All original field and analytical data reports, data reduction reports, QC information, and chain-of-custody forms will be kept on file by the HDR Project Manager. All electronic files associated with the EHOU OMMP will be periodically backed up until delivery of the Year 22 Final Monitoring Report and associated documents. At that time, data will be stored electronically by the USACE.

4.4.3 Data Analysis and Reporting

To maintain organization of data analysis activities, the HDR data manager will assist and oversee queries made of the database. Queries will be made of the EHOU OMMP database using data retrieval programs that screen for different analytical or environmental parameters. Data analysis will include conducting analyses that compare concentration values to background levels, Washington's SMS (Ecology 1995) or other applicable or relevant and appropriate requirements. Other analyses include comparisons of concentrations over time, with depth, or within particular regions of the study area.

Database queries will typically consist of a combination of site, location, station, sampling date, analysis type, compound or element, data validation qualifier, and upper and lower data values. Queried data can be exported into spreadsheet programs and manipulated for report presentation. All tabulated data reports and data analysis results will be presented in a standard format, clearly referenced to sources of data, and utilizing standard annotation. The HDR data manager will assist in the creation and implementation of reporting formats to be used during the monitoring, to ensure standardization and compatibility with EPA protocols.

4.5 Data Storage and Security

All documents generated during field and lab activities will be placed in the project files. Access to these records is controlled by the HDR project manager and will be restricted to authorized personnel working on the project. Electronic files will be maintained in EQuIS once data checking is complete.

4.6 Reporting

Following the field and laboratory work, a Year 22 monitoring report will be prepared to include the data analyses, and interpretation of the sediment sampling, results of the various surveys (bathymetric surfaces analysis, field surveys, aerial LIDAR and aerial imagery acquisition), and clam tissue analysis (completed by USACE and EPA).

The final monitoring report will include the following data elements:

- Scanned copies of field log books appended
- Field equipment and calibration information (included in the field notebooks), as applicable

- Sediment sample station location latitude and longitude provided from GPS instrumentation and input into EQuIS
- Coring logs
- Completed chain of custody forms
- Analytical laboratory data.

The final monitoring report will be provided to the EPA, Region 10 and USACE in electronic searchable pdf format. Both agencies will store, retain, and back up the document and all records associated with this project for periods of time prescribed by their respective agency's policies and regulations.

5.0 References

CH2M Hill. 1989. Final Remedial Investigation Report for Eagle Harbor site, Kitsap County, Washington. Prepared for U.S. EPA Region 10, Hazardous Site Control Division, Contract No. 68-01-7251. Prepared by CH2M-Hill, Bellevue, Washington.

Ecology. 1995. Washington State Department of Ecology. WAC 173-204. Sediment Management Standards.

EPA. 1994. EPA Superfund Record of Decision: Wyckoff Co./Eagle Harbor, EPA Id: WAD009248295, OU 01, Bainbridge Island, Washington. September 24, 1994. U. S. Environmental Protection Agency. Pub. No.: EPA/ROD/R10-94/079.

EPA. 2002. Guidance for Quality Assurance Project Plans. EPA QA/G-5. U.S. Environmental Protection Agency, Office of Environmental Information. Pub. No. EPA/240/R-02/009. December 2002.

EPA. 2007. Explanation of Significant Differences, Wyckoff/Eagle Harbor Superfund Site, East Harbor Operable Unit. September 2007.

EPA. 2015a. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review*, Office of Superfund Remediation and Technical Innovation, U.S. Environmental Protection Agency, September 2015. USEPA, 540-R-2016-001.

EPA. 2015b. *USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review*, Office of Superfund Remediation and Technical Innovation, U.S. Environmental Protection Agency, September 2015. USEPA, 540-R-2016-002.

EPA and USACE. 1995. Operations, Maintenance and Monitoring Plan Wyckoff/Eagle Harbor Superfund Site, East Harbor Operable Unit. Prepared for US Environmental Protection Agency, Region 10, Seattle, Washington and the US. Army Corps of Engineers, Seattle District. Prepared with assistance from Science Applications International Corporation. July 17, 1995.

HDR and SEE. 2011. Revised Final 2011 Operations, Maintenance, and Monitoring Plan Addendum Wyckoff/Eagle Harbor Superfund Site, East Harbor Operable Unit. Prepared for U.S. Environmental Protection Agency, Region 10 and U.S. Army Corps of Engineers, Seattle District. Prepared by HDR Engineering, Inc., and Science and Engineering for the Environment, LLC. May 10, 2011.

Integral and USACE. 2004. 2002-2003 Year 8 Environmental Monitoring Report East Wyckoff/Eagle Harbor Superfund Site, Harbor Operable Unit, Bainbridge Island, Washington. Prepared by Integral Consulting, Inc., and USACE. Prepared for USEPA. August 16, 2004.

SEA. 2002 Eagle Harbor, Field Sampling Plan, Monitoring Year 8, Operations, Maintenance and Monitoring Program, East Harbor Operable Unit, Wyckoff/Eagle Harbor Superfund Site. Prepared by Striplin Environmental Associates. Prepared for USEPA and USACE. October 25, 2002.

Tetra Tech. 1986. Preliminary Investigation, Eagle Harbor, Bainbridge Island, Washington. Prepared for Black and Veatch, Engineers-Architects. Prepared for the Washington State Department of Ecology, Tetra Tech, Bellevue, Washington.

USACE. 1994. On-scene Coordinator's Report. Statement of Findings. East Harbor Operable Unit Removal Action, Wyckoff/Eagle Harbor Superfund Site, Bainbridge Island, Washington. Final Draft. Prepared by the U.S. EPA Region 10 and the U.S. Army Corps of Engineers, Seattle District with Assistance By SAIC, Bothell, WA. July 26, 1994.

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Table PMP-1. Distribution List

Name	Position	Contact Information
U.S. Environmental Protection Agency, Region 10		
Helen Bottcher	Wyckoff/Eagle Harbor Superfund Project Manager	US EPA Region 10, ms ECL-122 Office of Environmental Cleanup 1200 Sixth Avenue, Suite 900 Seattle, WA 98101 phone: (206) 553-6069 email: bottcher.helen@epa.gov
Justine Barton	Sediment Technical Lead	US EPA Region 10, ms ETPA-088 1200 Sixth Avenue, Suite 900 Seattle, WA 98101-3140 phone (206) 553-6051 email: barton.justine@epa.gov
Donald M. Brown	EPA Region 10 QA Officer	US EPA Region 10, ms OERA-140 1200 Sixth Avenue, Suite 900 Seattle, WA 98101 phone (206) 553-0717 email: brown.donaldm@epamail.epa.gov
Don Matheny	EPA QA Manager	US EPA Region 10, ms OEA-095 1200 Sixth Avenue, Suite 900 Seattle, WA 98101-3140 phone (206) 553-2599 email: matheny.don@epa.gov
U.S. Army Corps of Engineers, Seattle District		
Ellen Brown	Project Manager	U.S. Army Corps of Engineers, Seattle District 4735 E Marginal Way S Seattle, WA 98134-2388 Phone: (206) 764-3536 email: Ellen.K.Brown@usace.army.mil
Marlowe Laubach	USACE QA Officer	U.S. Army Corps of Engineers, Seattle District 4735 E Marginal Way S Seattle, WA 98134-2388 Phone: (206) 764-3524 email: Marlowe.D.Laubach@usace.army.mil
Technical Contractor Team		
HDR Jeffrey Fellows	Project Manager Project H&S Officer	123 2nd Avenue, Suite 200 Edmonds, Washington, 98020 Phone: (425) 245-9139 Email: Jeffrey.Fellows@hdrinc.com

Table PMP-1. Distribution List

Name	Position	Contact Information
HDR David Wolfe	Project QA Officer	3284 NE 42nd Street Carnation, WA 98014 (717) 503-5819 email: David.Wolfe@hdrinc.com
HDR Kimberly Hawkins	Environmental Scientist	626 Columbia Street NW, Suite 2A Olympia, WA 98501 Phone: (360) 570-7266 Email: Kimberly.Hawkins@hdrinc.com
HDR Colin Mills	Data Manager	1 International Boulevard 10th Floor Suite 1000 Mahwah, NJ 07495 Phone (201) 335-9404 Emial: Colin.Mills@hdrinc.com
HDR Lynn Lutz	Data QA Officer	9781 S. Meridian Blvd, Suite 400 Englewood, CO 80112 Phone: (303) 754-4266 email: Lynn.Lutz@hdrinc.com
SEE Tim Thompson	Sediment Technical Lead Site H&S Officer	4401 Latona Avenue NE Seattle, WA 98105 Phone: (206) 418-6173 email: tthompson@seellc.com
SEE David Browning	Senior Sediment Scientist	5541 Keating Road NW Olympia, WA 98502 Phone: (360) 866-6806 email: david_browning@comcast.net
MCA Maps Jeffrey Kenner	Surveying Team Project Manager	19550 International Boulevard, Ste 203 Seatac, WA 98188 Phone: (206) 512.0301 email: jeffrey.kenner@mcamaps.com
Laboratory Analyses		
ARI Cheronne Oreiro	Laboratory Project Manager	4611 S 134th Place #100 Tukwila, WA 98168-3212 Phone: (206) 695-6214 email: cheronne@arilabs.com
EPA Manchester Laboratory Gerald Dodo	Analytical Project Manager Clam Tissue Analyses	7411 Beach Drive East Manchester, WA 98353 Phone: (360) 871-8728 email: dodo.gerald@epa.gov

Table PMP-2. Project Key Personnel and Responsibilities

Name	Role	Contact Information	Responsibilities
U.S. Environmental Protection Agency			
Helen Bottcher	Wyckoff/ Eagle Harbor Project Manager	US EPA Region 10, ms ECL-122 Office of Environmental Cleanup 1200 Sixth Avenue, Suite 900 Seattle, WA 98101 phone: (206) 553-6069 email: bottcher.helen@epa.gov	Provides oversight of all program activities. Reviews final project QA objectives, needs, problems, and requests. Approves appropriate QA corrective actions as needed.
Justine Barton	Sediment Technical Lead	US EPA Region 10, ms ETPA-088 1200 Sixth Avenue, Suite 900 Seattle, WA 98101-3140 phone (206) 553-6051 email: barton.justine@epa.gov	Assists in providing oversight of program activities. Reviews final project QA objectives, needs, problems, and requests.
Donald M. Brown	EPA Region 10 QA Officer	US EPA Region 10, ms OERA-140 1200 Sixth Avenue, Suite 900 Seattle, WA 98101 phone (206) 553-0717 email: brown.donaldm@epamail.epa.gov	EPA Region 10 QA Officer, provides oversight and concurrence for the review and approval of QAPP and laboratory QAP programs. Support EPA QA Manager, as needed, for project-specific oversight and approvals.
Don Matheny	EPA QA Manager	US EPA Region 10, ms OEA-095 1200 Sixth Avenue, Suite 900 Seattle, WA 98101-3140 phone (206) 553-2599 email: matheny.don@epa.gov	Reviews the QAPP and laboratory QAP (including SOPs) providing approval for laboratory analytical methods and procedures. Provides QA/QC support to the EPA RPM. Evaluates appropriate QA corrective actions.
U.S. Army Corps of Engineers, Seattle District			
Ellen Brown	Project Manager	U.S. Army Corps of Engineers Seattle District 4735 E Marginal Way S Seattle, WA 98134-2388 Phone: (206) 764-3536 email: Ellen.K.Brown@usace.army.mil	Provides oversight of all program activities. Reviews final project QA objectives, needs, problems, and requests. Approves appropriate QA corrective actions as needed. Provides liaison between contractor team and EPA.

Table PMP-2. Project Key Personnel and Responsibilities

Name	Role	Contact Information	Responsibilities
Marlowe Laubach	USACE QA Officer	U.S. Army Corps of Engineers Seattle District 4735 E Marginal Way S Seattle, WA 98134-2388 Phone: (206) 764-3524 email: Marlowe.D.Laubach@usace.army.mil	Reviews the QAPP and laboratory QAP (including SOPs) providing approval for laboratory analytical methods and procedures. Provides QA/QC support to the USACE Project Manager. Evaluates appropriate QA corrective actions.
Technical Contractor Team			
HDR Jeffrey Fellows	Project Manager	123 2nd Avenue, Suite 200 Edmonds, Washington 98020 Phone: (425) 245-9139 Email: Jeffrey.Fellows@hdrinc.com	Implements necessary actions and adjustments to accomplish program objectives. Oversees project performance and provides direction to accomplish project objectives. Ensures the project tasks are successfully completed within the projected time period. Maintains official copy of QAPP and all revisions. Administration, progress reporting, and invoice management.
HDR David Wolfe	Project QA Officer	3284 NE 42nd Street Carnation, WA 98014 (717) 503-5819 email: David.Wolfe@hdrinc.com	Provides senior technical QA support to the project work plan and reports.
HDR Kimberly Hawkins	Environmental Scientist	606 Columbia Street NW, Suite 200 Olympia, WA 98501 Phone: (360) 570-7266 Email: Kimberly.Hawkins@hdrinc.com	Assists the Project Manager to implement necessary action and adjustments to accomplish program objectives. Coordinates all facets of the project ensure completion in accordance with Work Plan.
HDR Colin Mills	Data Manager	1 International Boulevard 10th Floor Suite 1000 Mjahwah, NJ 07495 Phone (201) 335-9404 Emial: Colin.Mills@hdrinc.com	Performs input of field data and management of electronic data deliverable to meet project requirements for field database. Works closely with the Sediment Technical Lead. Manages to ensure the completeness and correctness of the field data deliverables.

Table PMP-2. Project Key Personnel and Responsibilities

Name	Role	Contact Information	Responsibilities
HDR Lynn Lutz	Data QA Officer	9781 S. Meridian Boulevard, Suite 400 Englewood, CO 80112 Phone: (303) 754-4266 email: Lynn.Lutz@hdrinc.com	Reviews and approves the AQAP. Reviews and approves laboratory QAP (including SOPs) for the project. Provides technical QA assistance to accomplish project objectives, including suggestions for corrective action implementation. Provides chemical data verification and validation and ensures validated chemical data are entered into the database.
SEE Tim Thompson	Sediment Technical Lead Field H&S Officer	4401 Latona Avenue NE Seattle, WA 98105 Phone: (206) 418-6173 email: tthompson@seellc.com	Prepares the FSP and assists in preparing the AQAP associated with the sediment sampling. Serves as Field Manager in conducting the sediment sampling in compliance with the FSP and QAPP. Supervises implementation of standard operating procedures, health and safety procedures, project modifications, and corrective actions during field operations. Serves as Sediment Site Health and Safety Officer. Ensures core logs are entered into the database. Prepares the draft and final monitoring report and recommendations for future actions.
SEE David Browning	Senior Sediment Scientist	5541 Keating Road NW Olympia, WA 98502 Phone: (360) 866-6806 email: david_browning@comcast.net	Assists in the preparation of FSP and AQAP. Conducts the sediment sampling in compliance with the FSP and QAPP at the direction of the Field Manager. Prepares the draft and final monitoring report.
MCA Maps Jeffrey Kenner	Surveying Team Project Manager	19550 International Boulevard, Ste 203 Seatac, WA 98188 Phone: (206) 512.0301 email: jeffrey.kenner@mcamaps.com	Oversees project performance, management, and reporting of survey team. Manages and implements topographical survey. Support data exchange and final survey data reporting.

Table PMP-2. Project Key Personnel and Responsibilities

Name	Role	Contact Information	Responsibilities
Laboratory Analyses			
ARI Cheronne Oreiro	Laboratory Project Manager	4611 S 134th Place # 100 Tukwila, WA 98168-3212 Phone: (206) 695-6214 email: cheronne@arilabs.com	Responsible for the analysis of sediment chemistry parameters. Ensures implementation of the project and laboratory QA plans, reports to KTA Data QA Officer, and serves as the laboratory point of contact.
EPA Manchester Laboratory Gerald Dodo	Analytical Project Manager Clam Tissue Analyses	7411 Beach Drive East Manchester, WA 98353 Phone: (360) 871-8728 email: dodo.gerald@epa.gov	Responsible for chemical analyses of clam tissue samples. Ensures implementation of the USACE QAPP for clam tissue analyses, and reports through the EPA RPM to the USACE Technical Lead.

Table PMP-3. Chronology of Events and Activities at the Wyckoff/Eagle Harbor Superfund Site, EHOU

Event/Activity	Date
The Wyckoff/Eagle Harbor site was added to the National Priority List (NPL)	1987
Completion of the Remedial Investigation (RI)	1989
Completion of the Feasibility Study (FS) for Eagle Harbor	1991
Removal Action – Placement of sand cap over 21.4 hectares of contaminated sediments	1993-1994
Construction monitoring of removal action	1993-1994
EPA completed ROD for the East Harbor OU, which included the following elements: (1) monitor and maintain the existing sediment cap, additional capping in remaining subtidal areas of concern; (2) monitor success of natural recovery in intertidal areas; (3) enhance existing institutional controls to reduce public exposure to contaminated fish and shellfish; (4) demolish in-water structures	1994
Baseline, Year 0 monitoring of subtidal cap	1994
Year 1 monitoring of subtidal cap	1995
Year 3 monitoring of subtidal cap	1997
Removal of in-water structures (e.g., piers and pilings)	1998-1999
1999 OMMP Addendum	1999
Year 5 monitoring of subtidal cap	1999
Installation of sheet pile wall around upland site	1999-2001
Intertidal investigation around the Wyckoff facility	1999-2002
Placement of Phase II subtidal cap	2000-2001
Placement of Phase III subtidal nearshore and intertidal cap	2001-2002
EPA created habitat Mitigation Beach at West Beach and placed Phase III subtidal nearshore and intertidal cap	2001-2002
2002 OMMP Addendum	2002
Year 8 monitoring of subtidal cap, intertidal cap, Mitigation Beach, and East Beach natural recovery	2002
First 5-Year Review	2002
Surface sediment samples in the visibly-contaminated areas of the West Beach Mitigation Beach	2005
West Beach intertidal sediment investigations	2005-2006
Second 5-Year Review (EPA 2007a)	2007
Explanation of Significant Difference (ESD) for the West Beach Exposure Barrier System (EBS)	2007
Construction of the West Beach EBS	2007-2008

Table PMP-3. Chronology of Events and Activities at the Wyckoff/Eagle Harbor Superfund Site, EHOU

Event/Activity	Date
2011 OMMP Addendum	2011
Year 17 monitoring of subtidal cap, intertidal cap, EBS, East Beach, and North Shoal natural recovery	2011
Additional East Beach and North Shoal investigations	2012
Third Five-Year Review	2012
Additional subtidal cap investigations (DNR-directed)	2014
Clam tissue collection and analyzed	2014
Proposed Plan for East Harbor and Upland OUs completed	2016
2016 OMMP Addendum	2016

Table PMP-4. Area and Monitoring Objectives (O&F denotes objective for the Operational and Functional Determination).

EHOU Objective A1		Area Objective	Monitoring Objective	Associated Field and Analytical Actions (for Discussion)	Evaluation Process and Criteria
O&F	5 YR				
Subtidal Cap (J9, J10)					
X	X	Determine if the cap meets cleanup goals as defined in the ROD.	Evaluate chemical isolation in surface capped sediments and determine the presence or absence of non-aqueous phase liquid (NAPL) in subsurface sediments	**Surface Sediment Samples.** Surface sediment (0-10 cm) samples from grids J9 and J10. Three grab samples from each grid will be collected and composited into one analysis for polycyclic aromatic hydrocarbons (PAHs), pentachlorophenol (PCP), mercury, total organic carbon (TOC), and grain size. Sediment from each grab sample will be reserved and archived for future analysis, if necessary.	Compare results to Washington State Sediment Management Standards (SMS) Minimum Cleanup Level (MCUL) or second Lowest Apparent Effects Threshold (2LAET).
North Shoal Subtidal Area (Grid Cells J7, J8, K7, K8, L8)					
	X	Characterization of the subtidal area of the North Shoal.	Evaluate chemical concentrations in subtidal surface sediments and determine the presence or absence of NAPL in subsurface sediments.	**Surface Sediment Samples.** Surface sediment (0-10 cm) samples from grid cells J7, J8, K7, K8, and L8. Three grab samples per grid will be collected and composited into one analysis for PAHs, PCP, mercury, TOC, and grain size. Sediment from each grab sample will be reserved and archived for future analysis, if necessary.	Compare results of surface samples to Washington State SMS MCUL or 2LAET.
	X	Visual characterization of subsurface sediment.	Determine the presence or absence of NAPL in subsurface sediments.	**Subsurface Sediment Cores.** A single subsurface sediment core (6-feet length) will be collected from grid cells J7, J8, K7, K8, and L8. Cores will be evaluated for the presence or absence of NAPL, sandy cap material, and other debris (e.g., wood, shells, etc.).	Visually evaluate subsurface cores for the presence or absence of NAPL, sandy cap material, and debris.
West Beach/EBS					
	X	Assess contaminant concentrations in surface sediments to evaluate potential human exposures.	Evaluate chemical concentrations in beach sediments.	**West Beach Surface/Subsurface Cores.** Surface/subsurface sediment cores (2-ft length) from the West Beach (includes the EBS and the area west of West Beach). Four sample stations based on the OMMP grid system were selected, plus two discretionary core locations (to be field determined). Three cores per sampling location will be collected, then composited into a single sample for analysis. Samples will be analyzed for PAHs, PCP, TOC, and grain size.	Compare results to SMS, Model Toxics Control Act (MTCA) Method B, and Preliminary Remediation Goals (PRGs).
X	X	Assess the effectiveness of placed cap at the EBS in isolating contaminants.	Evaluate physical stability of the West Beach and the EBS.	**West Beach Survey Program.** Surveys will be conducted in the West Beach area (EBS and west of West Beach) to evaluate current physical conduction of cap (including topographics, field, and bathymetric surveys, along with Airborne LIDAR and area imagery acquisition). **EBS Habitat Mix and Sand Cap Direct Measurement.** Measure the thickness of the EBS in eighteen locations.	Assess physical stability and trends at West Beach and the EBS.

Table PMP-4. Area and Monitoring Objectives (O&F denotes objective for the Operational and Functional Determination).

EHOU Objective A1		Area Objective	Monitoring Objective	Associated Field and Analytical Actions (for Discussion)	Evaluation Process and Criteria
O&F	5 YR				
X	X	Determine if intertidal areas provide functioning habitat.	Evaluate whether the placed remedies provide functioning habitat – natural recovery, and whether shellfish are safe for human consumption.	**Clam Tissue Samples.** USACE will collect clam samples from all intertidal areas.[1]	Track trends with previous tissue data and compare clam tissue chemistry results to standards for human health. [The proposed target tissue concentration for cPAHs is 0.12 µg/kg (benzo[a]pyrene) TEQ[2].

Note: 5 YR denotes objective for the upcoming 5 year review

O&F - operational and functional determination

TEQ - toxicity equivalency quotient

[1] Clam sampling was completed by USACE on July 5-6, 2016, prior to finalization of the 2016 OMMP Addendum.

[2] This is the selected target tissue concentration in the 2016 Proposed Plan for the East Harbor and Uplands OUs. Final target concentrations will not be determined until the ROD Amendment is issued.

Table PMP-5. Remedial Goals for Intertidal and Subtidal Areas

Analyte	Intertidal Sediment, Method B, Carcinogen, Direct Contact (ingestion only), unrestricted land use[A] (mg/kg)	Intertidal Sediment Method B, Non-carcinogen, Direct Contact (ingestion only), unrestricted land use (mg/kg)	Subtidal and Intertidal Sediment MCUL[C] (mg/kg OC)	Subtidal and Intertidal Sediment 2LAET [C] (mg/kg -dry) Used at and below 0.5% OC.	ROD Intertidal Sediment, Human Health (mg/kg)
Total LPAH	--	370	780	5.2	--
Anthracene	--	24,000	1,200	0.96	--
Acenaphthylene	--	--	66	1.3	--
Acenaphthene	--	4,800	57	0.5	--
Fluorene	--	3,200	79	0.54	--
Phenanthrene	--	--	480	1.5	--
Methyl naphthalene;1-	--	24	--	--	--
Methyl naphthalene;2-	--	320	64	0.67	--
Naphthalene	--	1,600	170	2.1	--
Total HPAH	--	--	5,300	17	1.2
Indeno (1,2,3,-C,D) Pyrene	0.14	--	88	0.69	--
Dibenzo (a,h) Anthracene	0.14	--	33	0.23	--
Benzo(g,h,i)Perylene	--	--	78	--	--
Benzo[a]anthracene	0.14	--	270	1.6	--
Benzo[a]pyrene	0.14	--	210	1.6	--
Benzo[b]fluoranthene	0.14	--	--	--	--
Benzo[k]fluoranthene	0.14	--	--	--	--
Total Benzofluoranthenes	--	--	450	3.6	--
Chrysene	0.14	--	460	2.8	--
Pyrene	--	2,400	1,400	3.3	--
Fluoranthene	--	3,200	1,200	2.5	--
Total PAH	1.4[B]	--	--	--	--
Pentachlorophenol	8.3	--	690	0.69	--

Notes:

A. The values shown are from the 2007 ESD and are individually at 1E-06 incremental lifetime cancers

B. Sum of Benzo(a)pyrene toxicity equivalents are not to exceed 1E-05 incremental lifetime cancers.

C. Sediment Management Standards MCUL expressed as mg/kg organic carbon; and 2LAET second Lowest Apparent Effects Threshold expressed as mg/kg dry weight .

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Table PMP-6. Washington State Sediment Management Standards for Subtidal Sediment Evaluation

Analytes	Sediment Management Standards	
	SQS	CSL
Conventional Inorganic Parameters (mg/kg)		
Total Organic Carbon	---	---
Grain Size	---	---
Metals		
Mercury	0.41	0.59
Organic Compounds		
Polycyclic Aromatic Hydrocarbons	**mg/kg OC**	
Total LPAH	370	780
Anthracene	220	1,200
Acenaphthylene	66	66
Acenaphthene	16	57
Fluorene	23	79
Phenanthrene	100	480
1-Methylnaphthalene	---	---
2-Methylnaphthalene	38	64
Naphthalene	99	170
Total HPAH	960	5,300
Indeno(1,2,3-cd)pyrene	34	88
Dibenz(a,h)anthracene	12	33
Benzo(g,h,i)perylene	31	78
Benzo(a)anthracene	110	270
Benzo(a)pyrene	99	210
Benzo(b)fluoranthene	---	---
Benzo(k)fluoranthene	---	---
Total Benzofluoranthene (b,j,k)	230	450
Chrysene	110	460
Pyrene	1,000	1,400
Fluoranthene	160	1,200
Dibenzofuran	15	58
Phenols and Substituted Phenols		
Pentachlorophenol	360	690

Notes:

mg/kg=milligram per kilogram

µg/kg=microgram per kilogram

mg/kg OC = milligram per kilogram organic carbon normalized

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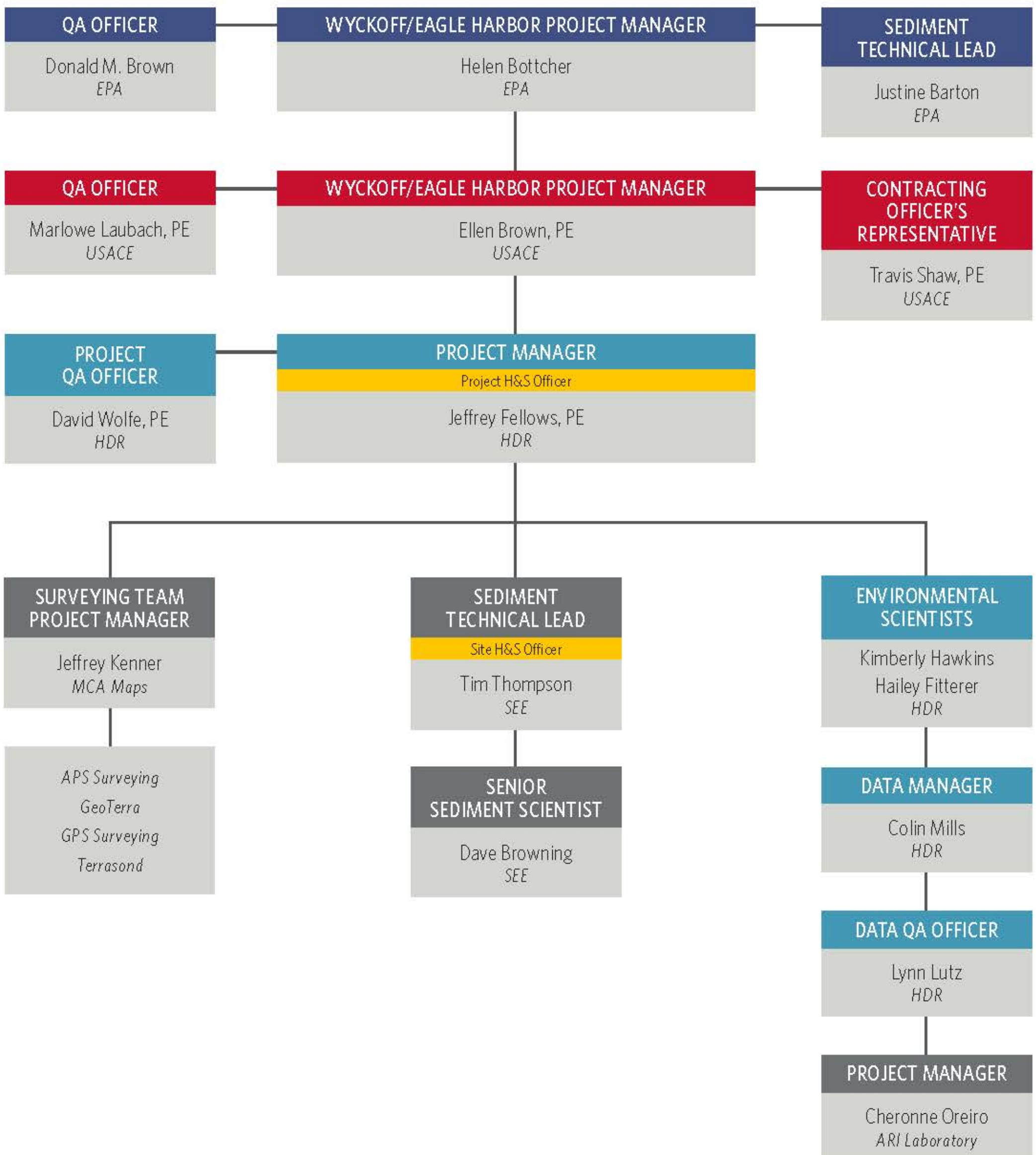
Figure PMP - 1

Organization Chart



Updated: 1/6/2016

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	Project Name	Figure Name	
SEE LLC Science & Engineering for the Environment / HDR	2016 OMMP Implementation East Harbor Operable Unit Wyckoff/Eagle Harbor Superfund Site	Aerial Photograph of the East Harbor Operable Unit, Wyckoff/Eagle Harbor Facility	**Figure PMP-2**

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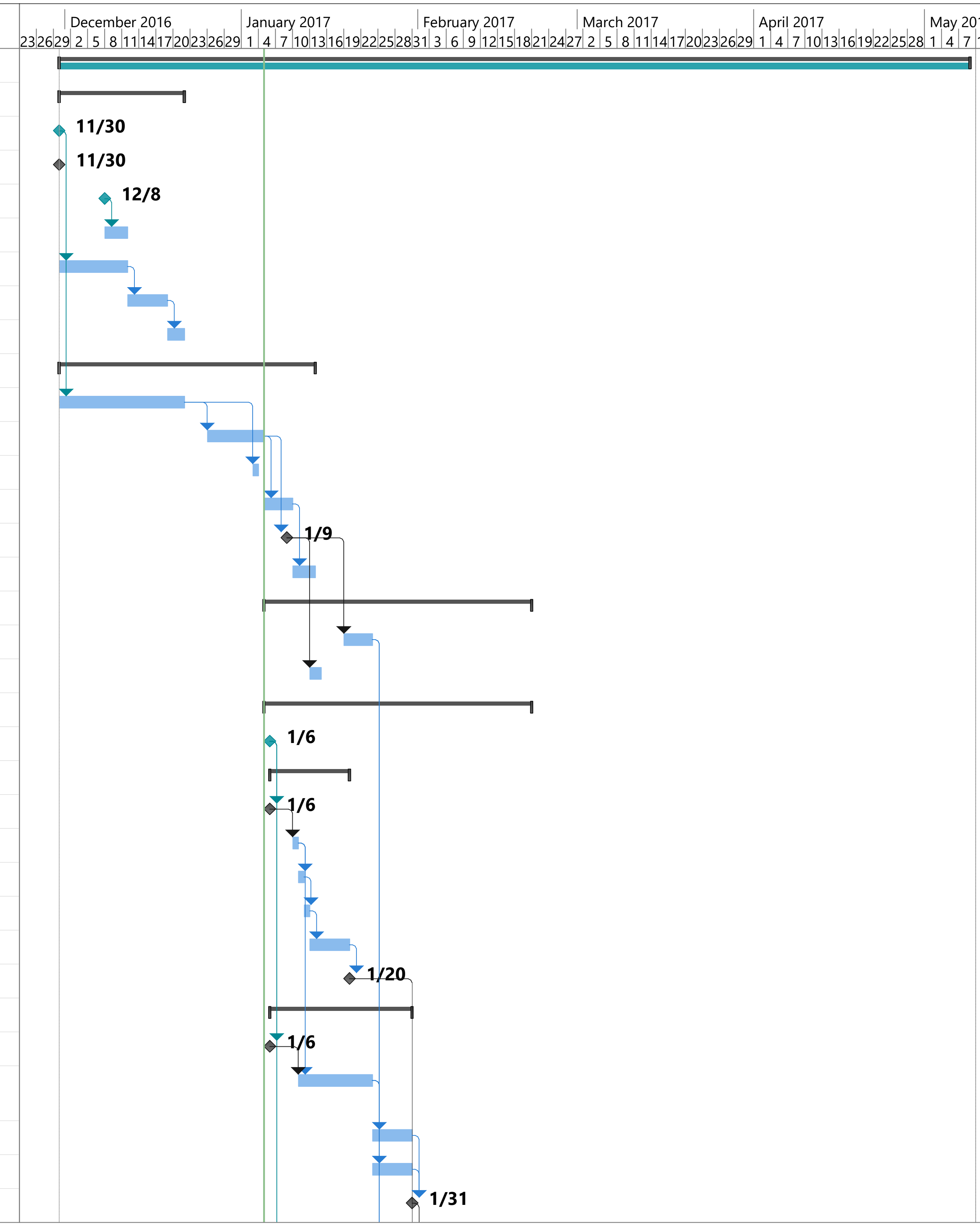
Project Schedule

Figure PMP – 3

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Wyckoff/Eagle Harbor 2017 OMMP Implementation Project**	**115 days**	**Wed 11/30/16**	**Tue 5/9/17**	
2	**Project Initiation and Kick-Off**	**16 days**	**Wed 11/30/16**	**Thu 12/22/16**	
3	Notice to Proceed (dated 30 November 2016)	0 days	Wed 11/30/16	Wed 11/30/16	
4	NTP to SEE, MCA, and ARI	0 days	Wed 11/30/16	Wed 11/30/16	
5	Project Kick-Off Meeting	0 days	Thu 12/8/16	Thu 12/8/16	
6	Kick-Off Meeting Notes	2 days	Thu 12/8/16	Mon 12/12/16	5
7	Draft Project Schedule for Review	8 days	Wed 11/30/16	Mon 12/12/16	3
8	USACE and EPA Comments on Draft Schedule	5 days	Mon 12/12/16	Mon 12/19/16	7
9	Final Project Schedule	3 days	Mon 12/19/16	Thu 12/22/16	8
10	**Task 1 - Work Plan Development**	**32.94 days**	**Wed 11/30/16**	**Fri 1/13/17**	
11	Prepare Draft Work Plans (FSP, QAPP, IDW, and H&SP)	16 days	Wed 11/30/16	Thu 12/22/16	3
12	Review of Draft Plans by USACE and EPA	8 days	Mon 12/26/16	Wed 1/4/17	11
13	Participate in Review Meeting (as needed)	1 day	Tue 1/3/17	Wed 1/4/17	11
14	Revise Plan per Comments; Submit Final Plans	3 days	Thu 1/5/17	Mon 1/9/17	12
15	Preliminary Plan Approval to Support Field Work	0 days	Mon 1/9/17	Mon 1/9/17	12
16	Receive Final Approval of Plans from USACE and EPA	4 days	Tue 1/10/17	Fri 1/13/17	14
17	**Task 2 - Field Work**	**34 days**	**Thu 1/5/17**	**Tue 2/21/17**	
18	2.1 Subtidal Sediment Sampling	4 days	Thu 1/19/17	Mon 1/23/17	15
19	2.2 West Beach Sediment Sampling and Elevation Survey	1 day	Fri 1/13/17	Sat 1/14/17	15
20	**Task 2.3 Beach Elevation Survey (MCA)**	**34 days**	**Thu 1/5/17**	**Tue 2/21/17**	
21	Work plan approval by USACE and EPA	0 days	Fri 1/6/17	Fri 1/6/17	
22	**Field Survey**	**10 days**	**Fri 1/6/17**	**Fri 1/20/17**	
23	MCA NTP to APS	0 days	Fri 1/6/17	Fri 1/6/17	21
24	Set aerial targets	1 day	Tue 1/10/17	Wed 1/11/17	23FS+2 days
25	Tie aerial targets	1 day	Wed 1/11/17	Thu 1/12/17	24
26	Survey lidar check points	1 day	Thu 1/12/17	Fri 1/13/17	25
27	Survey data processing	1 wk	Fri 1/13/17	Fri 1/20/17	26
28	Deliverables to MCA	0 days	Fri 1/20/17	Fri 1/20/17	27
29	**Aerial Imagery**	**18 days**	**Fri 1/6/17**	**Tue 1/31/17**	
30	MCA NTP to GPS Surveying	0 days	Fri 1/6/17	Fri 1/6/17	21
31	Flight	2 wks	Wed 1/11/17	Tue 1/24/17	24,30
32	Initial imagery processing	5 days	Tue 1/24/17	Tue 1/31/17	31
33	ABGPS/IMU processing	5 days	Tue 1/24/17	Tue 1/31/17	31
34	Deliverables to MCA	0 days	Tue 1/31/17	Tue 1/31/17	32,33



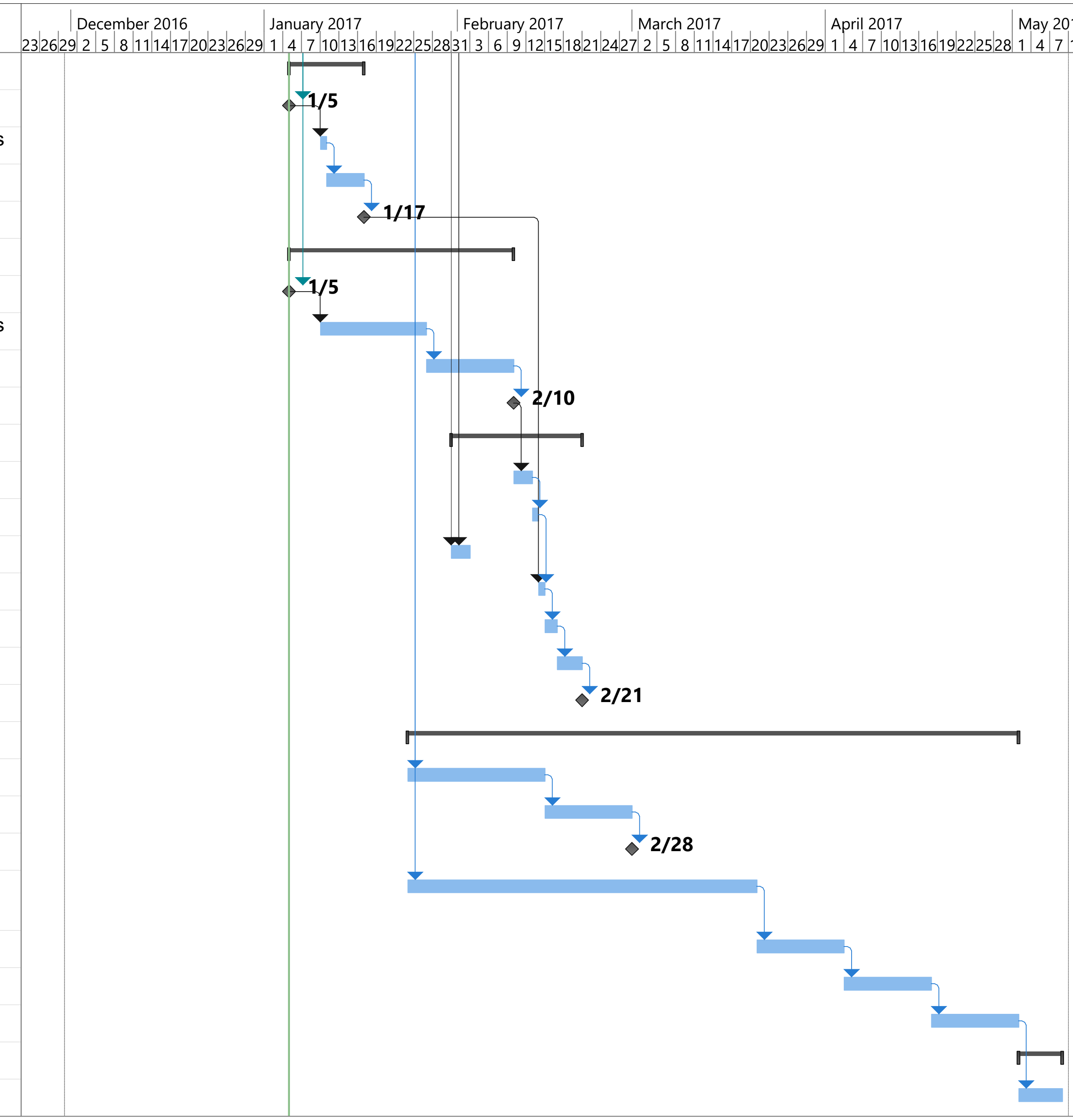
Project: Wyckoff_Final_Schedule
Date: Thu 1/5/17

Task, Split, Milestone, Summary, Project Summary, Inactive Task, Inactive Milestone, Inactive Summary, Manual Task, Duration-only, Manual Summary Rollup, Manual Summary, Start-only, Finish-only, External Tasks, External Milestone, Deadline, Progress, Manual Progress

Project Schedule

Figure PMP – 3

ID	Indicators	Task Mode	Task Name	Duration	Start	Finish	Predecessors
35			**Hydrographic Survey**	**8 days**	**Thu 1/5/17**	**Tue 1/17/17**	
36			MCA NTP to Terrasond	0 days	Thu 1/5/17	Thu 1/5/17	21FS-1 eday
37			Field operations	1 day	Tue 1/10/17	Wed 1/11/17	36FS+5 edays
38			Data processing	4 days	Wed 1/11/17	Tue 1/17/17	37
39			Deliverables to MCA	0 days	Tue 1/17/17	Tue 1/17/17	38
40			**Airborne Lidar**	**27 days**	**Thu 1/5/17**	**Fri 2/10/17**	
41			MCA NTP to GeoTerra	0 days	Thu 1/5/17	Thu 1/5/17	21FS-1 eday
42			Flight	14 days	Tue 1/10/17	Fri 1/27/17	41FS+5 edays
43			Initial processing/calibration	10 days	Fri 1/27/17	Fri 2/10/17	42
44			Deliverables to MCA	0 days	Fri 2/10/17	Fri 2/10/17	43
45			**Photogrammetry/Lidar/Ortho/Data Fusion**	**15 days**	**Tue 1/31/17**	**Tue 2/21/17**	
46			Lidar classification	1 day	Fri 2/10/17	Mon 2/13/17	44
47			Lidar edit	1 day	Mon 2/13/17	Tue 2/14/17	46
48			Aerial triangulation	3 days	Tue 1/31/17	Fri 2/3/17	28,34
49			Fuse lidar and bathy data	1 day	Tue 2/14/17	Wed 2/15/17	39,47
50			Orthorectification	2 days	Wed 2/15/17	Fri 2/17/17	49
51			Deliverable and report prep	2 days	Fri 2/17/17	Tue 2/21/17	50
52			Deliverables to HDR	0 days	Tue 2/21/17	Tue 2/21/17	51
53			**Task 3 - Reporting**	**70 days**	**Tue 1/24/17**	**Mon 5/1/17**	
54			Laboratory Analysis and Reporting	16 days	Tue 1/24/17	Tue 2/14/17	18
55			Data Review and Validation	10 days	Wed 2/15/17	Tue 2/28/17	54
56			**Initial Data Results to USACE and EPA**	**0 days**	**Tue 2/28/17**	**Tue 2/28/17**	**55**
57			Draft Monitoring Report Submittal for USACE and EPA Review	40 days	Tue 1/24/17	Mon 3/20/17	18
58			Receipt of comments from USACE and EPA on draft	10 days	Tue 3/21/17	Mon 4/3/17	57
59			Final Report submittal for USACE and EPA approval	10 days	Tue 4/4/17	Mon 4/17/17	58
60			Final Approval	10 days	Tue 4/18/17	Mon 5/1/17	59
61			**Project Closeout**	**5 days**	**Tue 5/2/17**	**Mon 5/8/17**	
62			Document Archive and Final Closeout	5 days	Tue 5/2/17	Mon 5/8/17	60



Project: Wyckoff_Final_Schedule
Date: Thu 1/5/17

Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

2016 Final Quality Assurance Project Plan

Field Sampling Plan

East Harbor Operable Unit

Wyckoff/Eagle Harbor Superfund Site

January 9, 2017

Prepared for:

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1.0 Introduction

This Field Sampling Plan (FSP) describes the detailed field sampling and analysis procedures to be conducted during the Year 22 monitoring implementing the 2016 Operations, Maintenance, and Monitoring Plan (OMMP) Addendum (USACE and EPA 2016) for the Wyckoff/Eagle Harbor Superfund Site, East Harbor Operable Unit (EHOU) located on Bainbridge Island, Washington (Figure FSP-1). This monitoring includes physical elevation monitoring, surface and subsurface sediment samples for physical and chemical analyses, and biological tissue analyses[1]. The monitoring objectives, and the specific data collected to address those objectives may be found in Table PMP-4 of the Project Management Plan (PMP), and in Table 1 of the OMMP.

This FSP provides specific guidance for field and quality assurance procedures that will be followed by HDR Engineering, Inc. (HDR) and Science and Engineering for the Environment, LLC (SEE), and their subcontractors during Year 22 monitoring. HDR is the prime contractor conducting this work under contract to the U.S. Army Corps of Engineers (USACE), Seattle District, with direction from the USACE and the U.S. Environmental Protection Agency (EPA), Region 10. The FSP is specifically limited to field activities during Year 22 monitoring studies of the EHOU as described in the 2016 OMMP.

1.1 Project Location

The Wyckoff/Eagle Harbor Superfund site is located on the eastern side of Bainbridge Island in central Puget Sound (Figure FSP-1). Eagle Harbor is an east-west trending embayment whose mouth to Puget Sound lies at the eastern reach. The bay is approximately 2 square kilometers in area, and approximately 3.7 kilometers long; it is widest (0.9 kilometers) just inside its entrance, becoming progressively narrower to the west. Water depths are 15 to 18 meters below mean lower low water at the entrance, gradually becoming shallower to the west.

The Wyckoff/Eagle Harbor Superfund site encompasses contaminated areas of Eagle Harbor and the 16 hectare (40 acre) upland and intertidal regions of the former Wyckoff wood-treating facility, as well as other upland sources of contamination to the harbor, including the former shipyard on the north shore. The site is currently divided into three operable units (OUs) or management areas: the East Harbor OU, the West Harbor OU, and the Soil and Groundwater OU. Figure FSP-1 shows the project location within Eagle Harbor, while Figure FSP-2 shows where subtidal and intertidal caps have been placed at the Wyckoff/Eagle Harbor East Harbor OU.

1.2 Components of the Work Plan

This FSP is one component of the Year 22 Monitoring Work Plan that implements the 2016 OMMP Addendum. The Year 22 Work Plan and this FSP are updates of the 2011 Year 16 OMMP Work Plan and supporting documents (HDR and SEE 2011). Cap maintenance, as well as additional remedial construction, are planned or under consideration for the Phase I and II capping areas, in the area of the former facility West Dock (potentially impacting the Phase III Cap and North Shoal), along the North Shoal, and at East Beach (Figure FSP-2). A proposed plan was issued in 2016 for

[1] Biological tissue sampling and analysis is the responsibility of the USACE; sampling was completed in July 2016.

public comment proposing to amend the remedial action in the 1994 ROD. Long-term monitoring for these areas is deferred until completion of the planned/proposed construction.

The five documents listed below comprise the Year 22 EHOU Monitoring Work Plan:

Quality Assurance Project Plan (QAPP). The QAPP is the overall plan for monitoring including objectives, monitoring plan design, measurement methods (types of data to be collected), schedule, deliverables, use of monitoring results in site management, the project team, and project responsibilities. The QAPP has three primary components including the: PMP, Field Sampling Plan (FSP), and Analytical Quality Assurance Project Plan (AQAP). The Investigation Derived Waste Plan (IDWP) and Health and Safety Plan (HSP) are also prepared to supporting implementation of the scope of work (SOW) outlined in the QAPP and associated documents.

Project Management Plan. The PMP is the bridge document for the QAPP. In addition to providing the overall project organization and personnel responsibilities, the PMP provides the program elements common to the field and analytical monitoring including site information and history, monitoring objectives of the 2016 OMMP Addendum, personnel training requirements, data management, reporting requirements, and an overall schedule for completion of the monitoring and reporting.

Field Sampling Plan. The FSP describes the field procedures and detailed activities including physical elevation monitoring, surface and subsurface sediment samples for chemical analyses, and biological tissue residue analyses (biological ties analysis managed by the USACE). The FSP addresses sample analyses procedures only from sample collection up to delivery to the analytical laboratories or data reduction locations.

Analytical Quality Assurance Project Plan. The AQAP provides the details of field sampling and analytical procedures that will be followed so that the environmental data are of known and documented quality and suitable for their intended uses, and the environmental data collection and technology programs meet stated requirements. It includes the data quality objectives of sample collection, numbers and types of stations to be sampled for each data type, field procedures, and instrumentation. The chemical analysis component includes detailed direction to the analytical laboratory on analytical methods, data quality objectives, sample custody, quality assurance and quality control (QA/QC) procedures, data deliverables, data management, and reporting. The AQAP is provided to office personnel and the analytical laboratory.

Investigation-Derived Waste Plan. The IDWP details the handling procedures, containerization, and disposal of investigation derived wastes (IDW) generated during the monitoring program, including decontamination products, excess sample material, and protective equipment.

Health and Safety Plan. This plan describes the procedures and equipment that will be used to protect the health and safety of project staff and the public during monitoring. The HSP identifies chemical and physical hazards, types of work zones, protective equipment and procedures, responsible individuals, and an emergency plan.

1.3 Site Terminology

Throughout this document specific terms will be used to reference the study areas within the EHOU. Figures FSP-2 and FSP-3 show the areas of the EHOU that have been remediated along with the extent of individual removal actions or remedial activities. Below are the definitions of specific terminology for each action and study area for the EHOU.

1994 Phase I Subtidal Cap. The 1994 Phase I subtidal cap was placed in 1994-1995 as part of a Non-Time Critical Removal Action (NTCRA). This NTCRA consisted of placement of an approximately 1 meter (m) (3 feet [ft]) thick sediment cap over 21.4 hectares of subtidal sediments. Figure FSP-2 depicts the extent of the 1994 Phase I sediment cap.

2000 Phase II Subtidal Cap. Figure FSP-2 shows the 2000 Phase II subtidal cap, which was placed to augment the 1994 Phase I cap. The 2000 Phase II cap overlaps the Phase I cap at its southern boundary, and covers uncapped shallow subtidal sediments not previously capped during the 1994 NTCRA. In the area where the 2000 cap overlaps the 1994 NTCRA, cap materials were placed to cover surface sediments with polycyclic aromatic hydrocarbon (PAH) concentrations that were above the Washington State Sediment Quality Standards (SQS), as reported in the 1999 Year 5 monitoring results.

2001 Phase III Subtidal Cap. The 2001 Phase III cap extends shoreward from the 2000 Phase II cap. It overlaps both the 1994 Phase I and 2000 Phase II caps. It was placed over uncapped shallow subtidal sediments and intertidal sediments. Figure FSP-2 shows the extent of the 2001 Phase III subtidal cap.

Exposure Barrier System (EBS). The EBS, completed in 2008, covers approximately 5.1 acres of intertidal and shallow subtidal sediments on West Beach. The location of the EBS is shown in Figures FSP-2 and FSP-3.

Intertidal Cap. The intertidal cap is the extension of the 2001 Phase III subtidal cap shoreward, covering the intertidal surface sediments where PAH concentrations exceeded the SQS. Figures FSP-2 and FSP-3 depict this cap.

North Shoal. The North Shoal consists of the intertidal area on the north shore of the former Wyckoff facility. It is bounded to the west by the intertidal cap and to the east by East Beach. Figure FSP-3 shows the North Shoal area. Additional sampling will also be undertaken in Year 22 in the subtidal area of the North Shoal to support remedial decisions.

East Beach. East Beach consists of the intertidal area on the eastern side of the former Wyckoff facility. As depicted in Figure FSP-3, it is bounded to the north by the North Shoal and extends southward to the Wyckoff property boundary.

West Beach. West Beach (formerly known as the Mitigation Beach) lies at the western edge of the Wyckoff facility property boundary and encompasses both the EBS and the riparian habitat upland from the intertidal EBS. West Beach and the delineation of the EBS and the Intertidal Cap are shown in Figure FSP-3. The former Mitigation Beach was constructed in 2000 and 2001 with the areas above +17 ft MLLW vegetated to provide riparian habitat around the Wyckoff facility which, with the EBS, constitutes West Beach.

1.4 Monitoring Elements and Tools to Address the 2016 OMMP Addendum

A brief description of the salient monitoring elements and the tools that will be used to address those in the 2016 OMMP Addendum are presented below. The technical rationale for each monitoring technology, its goals within the 2016 OMMP Addendum and the areas of the EHOU where the monitoring technologies are applied are shown in the PMP as Table PMP-4. Associated analytical methods are described in the AQAP.

1.4.1 Physical Stability Monitoring

Physical stability measures are used to compare current conditions to historical conditions, support an evaluation of whether additional actions are needed if differences are significant, and to support the conceptual site model.

The 2011 monitoring results demonstrated that the majority of the subtidal sediment cap is performing as intended using a bathymetry survey and cap thickness measurements determined from through-cap coring. However, the 2011 monitoring, and subsequent monitoring by the Washington State Department of Natural Resources, demonstrated substantial loss of the subtidal cap located within the ferry navigation lanes.

EPA and the USACE are implementing site maintenance activities in 2017 to repair a portion of the Phase I cap in the ferry navigation channel (Figure FSP-2). EPA has also proposed additional cleanup actions in the intertidal sediments of the North Shoal and East Beach (EPA Proposed Plan 2016). As a result of these ongoing site construction activities, physical and chemical monitoring on the Phase I, Phase II, and Phase III caps, as well as monitored natural recovery, monitoring for East Beach and North Shoal are deferred. Subtidal sediment sampling in grids J7, J8, J9, J10, K7, K8, and L8, included as part of the program discussed herein, will provide a general assessment of potential contamination in this area, much of which has been sparsely characterized to date.

Physical confirmation sampling has not been completed at the EBS or along West Beach since 2011. Physical stability measurements will be undertaken in these areas in 2016, and include the following:

Bathymetry. Bathymetry has been an integral part of subtidal cap monitoring since the 1994 NTCRA, and in each subsequent monitoring event. The objective of the Year 22 bathymetry, when used in conjunctions with the beach elevation surveys, is to evaluate the physical stability of the EBS and West Beach. The bathymetric surveying is similar to that completed for the 1995 OMMP, and the 1999, 2002, and 2011 OMMP Addenda. One significant change is that the bathymetry will be conducted using both single beam sonar (as has been done in previous surveys), and also using multibeam sonar. Future bathymetric monitoring at the EHOU will be completed using multibeam. The objective of the concurrent sonar measurements is to document the similarities and differences on shore profiling using the two methods. Bathymetric surveys will be conducted by subcontracting firm TerraSond, who is under contract to Miller Creek Aerial Mapping (MCA). The specific elements of the bathymetric survey are discussed in Section 5 and in Appendix B.

Beach Elevation Surveys. Beach elevation surveys are used to confirm the physical stability of intertidal remedial construction efforts and support evaluation of the EBS and West Beach stability. Beach elevation surveys will be conducted using photogrammetry and lidar equivalent to what was completed in the 2011 survey. This work will be performed by MCA; the specific elements are discussed in Section 5 and in Appendix B.

1.4.2 Chemical Isolation Monitoring

Sediment surface and subsurface samples are used to confirm that the sediment cap remedy is isolating the chemicals of concern. All chemical isolation monitoring is conducted by the contractor team. Measures used to ensure chemical isolation include the following:

Subtidal Cap Surface Sediment Collection. Surface sediment grab samples (0-10 centimeters [cm]) will be collected from Grid J9 and J10 (Figure FSP-4), where cap material did not meet the target cap thickness[2]. These are discussed in more detail in OMMP. Three discrete grab samples will be collected at both J9 and J10; the three grab samples will be composited into a single sample for chemical analyses. Additional sediment from each collected discrete grab sample will be archived for potential later analyses. Station locations for subtidal cap surface chemistry are shown in Figure FSP-5. Specific station coordinates and sample collection are shown in Tables FSP-1; samples to be processed and analyzed in Table FSP-2. Methods for subtidal cap surface sediment collection are discussed in Section 5.2.

Subtidal Cap Subsurface Sediment Collection. Subsurface sediments will not be collected from the subtidal cap areas for the Year 22 monitoring.

EBS and West Beach Sediment Core Collection. Sediment cores will be collected from the EBS and the area west of West Beach (east of the marina). Cores will be 0 to 2 feet depth, or to the depth of the cobble (whichever is shallower). Three grab samples from each targeted location will be composited into one sample for analysis (total of 6 samples). Collecting cores from the 0- to 2-foot depth interval is a departure from previous monitoring events, when surface sediments were collected from a depth of 0 to 10 cm. In the 2016 Proposed Plan, EPA proposed changing the point of compliance for intertidal sediment from the 0 to 10 cm interval to the top 2 feet, recognizing that people using the beach for recreation or shellfish collection would be exposed to sediment deeper than the top 10 cm. EPA plans for this change apply only to intertidal sediment with the potential for direct human exposure. EBS and West Beach sampling locations are shown in Figure FSP-6, with coordinates provided in Table FSP-1. Specific analyses are given in Table FSP-2. The EBS and West Beach surface sediment collection methodology and sampling strategy is discussed in Section 5.2.

1.4.3 Natural Recovery Monitoring

Natural recovery is the identified remedial alternative for the North Shoal and East Beach. No natural recovery monitoring will be conducted in the 2016 OMMP Addendum. A proposed plan for a new remedial action in the North Shoal and East Beach areas was issued in 2016.

1.4.4 Biological Monitoring

Biological monitoring is conducted to help address whether the remedies provide functioning habitat, and where shellfish occur, to determine if those shellfish are safe for human consumption. While the 2011 OMMP addendum included a forage fish habitat use survey, a wildlife area use survey, and biological tissue collection, only clam tissue collection and analyses are planned for the Year 22 monitoring. As noted in Section 1.2, additional surveys are deferred at this time until the cap maintenance that is currently underway is completed and potential remedial construction considerations are evaluated and planned.

Clam Tissue Collection. The collection of clam tissue samples from East Beach and North Shoal sediments was first included in the 2002 OMMP Addendum. The 2011 OMMP Addendum also included clam tissue (*Tresus capax*) sampling from the Intertidal Cap and West Beach, including the EBS. An additional collection of horse clam (*Tresus capax)* tissue occurred in 2014 from locations within the Intertidal Cap, North Shoal, West Beach, and East Beach locations (USACE 2015). The

[2] Grids J9 and J10 include the former West Dock area, which is being considered by EPA for additional remedial action. The samples from these grids were included in the 2011 OMMP as subtidal cap samples, and are thus included here.

2016 field effort was conducted in July 2016. The focus was on collecting clams in all four of the target areas plus a background location identified by the Suquamish Tribe within their Usual and Accustomed fishing areas. The purpose of the collection and analysis of clam tissues is to assess the extent of natural recovery since the 2011 monitoring event and to provide additional human health risk information.

Clam tissue collection, analyses and reporting are being conducted by the USACE; the methods are described in a separate sampling and analysis plan (Appendix A).

1.4.5 Additional Monitoring

North Shoal Subtidal Sediment Collection. The subtidal areas of the North Shoal east of the Phase I cap have not been previously characterized. Surface samples and subsurface cores will be collected in the areas within Grids J7, J8, K7, K8, and L8 (Figure FSP-4) in order to characterize this area. Three surface grab samples per grid area will be collected (Figure FSP-5), which will be composited for analysis. For each surface grab sample collected, a single archived sediment sample will be retained (a total of 15 archived grab samples). One subsurface sediment core (6 ft length) per grid area will be collected to determine the presence or absence of non-aqueous phase liquid (NAPL), sandy cap material, other debris (e.g., woody debris, shells). No chemical analyses will be conducted on the collected core samples. Coordinates for these individual sampling locations are given in Table FSP-1. Subsurface coring is discussed in Section 5.3.

2.0 Objectives and Scope

The program objectives for Year 22 monitoring are outlined in the 2016 OMMP Addendum and in the PMP Table 4. These objectives support the goals of contaminant isolation monitoring for the EBS and provide additional data for remedial decision making at the subtidal areas near the historical West Dock and the North Shoal subtidal area.

2.1 Objectives

The specific monitoring objectives, the tools that will be employed to provide data on those questions, and how those data may be used are summarized in PMP Tables PMP-4 through PMP-6.

2.2 Scope of Field Work

Specific elements of Year 22 monitoring are summarized below. Physical monitoring of subtidal and intertidal areas, and biological tissue monitoring, will be accomplished separately by the USACE. The elements of Year 22 monitoring addressed in this FSP include:

Focused Sampling at Grids J-9 *and J-10* - Surface sampling within Grids J9 and J10 will be collected, composited, and analyzed for the suite of conventional and chemical parameters listed in Table FSP-2. Within each grid, three (3) surface samples will be collected and composited into one sample for analysis. Results of these analyses will be compared to the Washington State Sediment Management Standards (SMS), see PMP Table PMP-6.

Exposure Barrier System and West Beach Sediment Core Collection and Monitoring - EBS and West Beach monitoring will include visual seep surveys, a physical assessment of cover thickness, and sediment chemistry. A total of six (6) locations on the EBS and West Beach will be sampled for surface sediments (0-2 ft) and analyzed for PAH, pentachlorophenol (PCP), and conventional parameters.

North Shoal Subtidal Area Sediment Collection - Surface sediments (0-10 cm) will be collected at five (5) intertidal locations and analyzed for PAH, PCP, mercury, and conventional parameters to identity if surface sediments along the North Shoal have PAH concentrations that exceed the SMS.

Clam Tissue Collections - Collect clams from locations from the intertidal areas from the West Beach/EBS, the Phase III cap, and East Beach. Tissues are analyzed for PAH and lipids content to provide information of biological uptake of PAH, and used to assess potential risk. Clam Tissue collection and sampling was previously completed by the USACE (July 2016).

2.2.1 Subtidal Cap Monitoring

Subtidal surface sediment composites will be collected from Grids J9 and J10; no cores will be taken. Surface sediment composites will be analyzed for PAHs, PCP, mercury, and conventional parameters. The purpose of this monitoring is to provide further information to inform remedy design/decisions within the area of the historical West Dock.

For Year 22 monitoring, stations are defined based on the grid-sampling design initiated in the 2002 OMMP Addendum. Grids J9 and J10 are shown in Figure FSP-4; the individual grab sampling locations in Figure FSP-5. Individual sampling locations are presented in Table FSP-1. Sample analyses are summarized in Table FSP-2. For surface sediments, a minimum of three replicate grab samples will be collected from the same locations sampled in 2011.

2.2.2 Exposure Barrier System and West Beach Monitoring

EBS and West Beach monitoring will include physical stability, visual seep surveys, and sediment chemistry. Physical stability will be assessed using a comparison of the 2016 combined elevation surveys to the 2008 as-built EBS conditions, following the approach presented in the 2011 Year 16 Monitoring Report (HDR and SEE 2011). Confirmation of physical stability will also include hand-measures of the cover thickness, to the extent practicable, by pushing a measuring rod through the fish habitat fill and recording both the location of the measure and the length the rod passes through the fish habitat fill before contacting the underlying rock layer.

A total of five (5) locations on the EBS will be sampled in the top 2 ft, or to the depth of the underlying cobble layer, and analyzed for PAH, PCP, and conventional parameters. Three of the EBS locations sampled in 2011 (Grids F12, H12, and I12) will be sampled again (Table FSP-1 and Figure FSP-6). An additional two discretionary grids within the EBS will be sampled based upon field observations. Criteria for selecting these discretionary stations include visible seeps, hydrocarbon odor, visible erosion of the EBS cover, and/or the observation that the cover thickness is less than the 2-foot minimum required of the EBS. Throughout the sampling efforts the EBS will be monitored for seeps. Results of the chemical analyses will be compared to the EHOU 1994 Record of Decision and 2007 Explanation of Significant Difference Sediment Standards Chemical Criteria. These criteria are included in Table 1 of the OMMP.

2.2.3 North Shoal Subtidal Area Sediment Collection

Monitoring of the North Shoal consists of the collection of subtidal surface sediments (0-10 cm) from five (5) grids: J7, J8, K7, K8, and L8. Location of these grids is shown in Figure FSP-4; the specific sampling locations are given in Figure FSP-5 and in Table FSP-1. The purpose of the surface sediment monitoring is to confirm whether sediments in the North Shoal subtidal area remain uncontaminated relative to the SMS. Sediments will be analyzed for PAHs, PCP, mercury, and conventional parameters for comparison to the SMS. Stations on the North Shoal subtidal area to be sampled are shown in Figure FSP-5 and listed in Table FSP-1. Analyses to be conducted are shown in Table FSP-2.

2.2.4 Biological Monitoring

Shellfish tissue has been contaminated in the past primarily with PAHs at concentrations that posed a risk to subsistence-level and recreational shellfish consumers due in part to potential chemical contamination associated with the Wyckoff/Eagle Harbor Superfund site. The shellfish survey will serve two purposes. Clams will be collected to assess habitat use by the clams in the intertidal areas of at West Beach, the Intertidal cap, North Shoal, and East Beach. Clam tissue analysis will be conducted from clams gathered at North Shoal and Intertidal Beach to evaluate whether natural recovery has resulted in a decrease in PAH concentrations within clam tissue, and whether or not they are suitable for human consumption based on health protective values to be derived. Clam sampling has been conducted by the Corps, with the tissue chemical analyses being done by EPA's Manchester Laboratory.

3.0 Project Organization and Responsibilities

This section identifies individuals responsible for specific aspects of field sampling for Year 22 monitoring. The overall project management is defined in PMP, with contact information provided in Table PMP-1. Personnel responsible for laboratory analysis, quality assurance, data management, and reporting of the physical, chemical, and biological monitoring are detailed in the QAPP, but are also briefly mentioned in this document in relation to successfully accomplishing the field sampling associated with Year 22 monitoring.

3.1 Monitoring Personnel

HDR and its team will conduct the field activities and sample collection specified within this FSP. The overall project personnel and assigned responsibilities are given in the PMP Table PMP-2; the organizational chart in Figure PMP-1.

Jeff Fellows, PE, is the HDR project manager and the project health and safety officer. He is the contractual point of contact for the USACE and EPA.

Elevation mapping will be led by MCA Maps; Jeffrey Kenner is the surveying team project manager. The survey team includes APS Surveying and Mapping (field surveys), TerraSond (bathymetric surveys), GeoTerra (airborne lidar acquisition), and GPS Surveying (aerial imagery acquisition. Methods for the elevation surveys are discussed further in Section 5.1; the scope is presented in Appendix B.

Tim Thompson and David Browning of SEE will coordinate and conduct the physical and chemical monitoring tasks, as well as analysis and reporting. Mr. Tim Thompson will serve as the sediment technical lead and the sediment site health and safety officer for the field work. SEE is the technical point of contact for the USACE and EPA.

Analytical Resources, Inc. (ARI), will conduct all chemical and conventional analyses for sediments and rinsates. Ms. Cheronne Oreiro is the laboratory project manager for ARI. Archived samples will be stored at ARI until the conclusion of the period of performance for the Year 22 monitoring, at which time the samples will be transferred to the USACE or disposed at the direction of the USACE. QA/QC oversight of laboratory will be the responsibility David Wolfe, PE, of HDR.

Subtidal sampling will be conducted from the *R/V Nancy Anne*, operated by Marine Sampling Services (MSS). Mr. Tim Thompson and/or Mr. David Browning in tandem with Mr. Bill Jaworski of MSS will be responsible for station positioning for the on-water field efforts for monitoring. Mr. Browning will be responsible for positioning/surveying associated with intertidal sediment. A sub-meter accuracy differential global positioning system will be used for all sampling activities. The shipboard global positioning system (GPS) will be provided by Mr. Bill Jaworski for sampling activities conducted aboard the *R/V Nancy Ann*.

A backpack differential GPS will be used during the intertidal sediment and tissue collections. On the research vessel, the GPS will be interfaced to an integrated navigation system that will store target sampling locations, provide a plan-view display of the vessel position relative to the target sampling location, and record the location of sample acquisition once the sample is taken.

3.2 Physical, Chemical, and Biological Monitoring Task Coordinators

The managers of the physical, chemical and biological monitoring efforts, along with their sampling (measurement tools) responsibility are listed below. These managers will be responsible for managing field sampling and survey work, laboratory analysis, data analysis and interpretation, and reporting for the listed monitoring methods. They will also be responsible for directing staff, coordinating with the HDR project manager, and preparing all reports and other work products in their technical area.

Monitoring Type	Manager	Measurement Tools
Physical	Jeff Kenner, PE MCA Maps	Bathymetry Beach Elevation Surveys
Chemical	Tim Thompson David Browning	Sediment Coring Surface Sediment Chemistry
Biological	USACE	Clam Tissue Collection

3.3 Field Sampling Personnel

The personnel listed in the above table will conduct the field program. HDR scientists involved with the field sampling will include Kimberley Hawkins and Hailey Fitterer. Field personnel conducting the chemical sediment sampling have extensive marine sampling and/or biological monitoring experience and are familiar with the methods for conducting this work. Field personnel conducting sediment sampling have current health and safety certification as required by Occupational Safety and Health Administration 29 Code of Federal Regulations 1910.120.

In the event additional personnel are necessary, other personnel with marine sampling experience will assist in conducting the field work. At a minimum, those individuals will have current health and safety certification and will be required to read and comply with the relevant sections of this FSP and the HSP.

4.0 Field Project Schedule

The overall schedule for the project is presented in the PMP in Table PMP-4. The projected schedule for the field sampling for Year 22 monitoring of the EHOU is presented in Table FSP-3. Note that the sampling of clam tissues was decoupled from sediment sampling; it was necessary to sample the clams in the summer; typically a time of high clam tissue lipid content. This has been completed by the USACE; the work plan for those activities is in Appendix A.

Field activities for the EHOU monitoring during Year 22 monitoring will take place over approximately three weeks in January 2017. The projected schedule is tentative and dependent on the progress of Work Plan approval and the timing of each monitoring element.

The following sequence of field sampling events is anticipated:

- Aerial topographic surveys will take 1 day, but are weather contingent.
- Bathymetric surveys will take 1 day, and are tidal contingent.
- EBS and West Beach sediment core sampling is estimated to take 0.5 days.
- Mobilization and setting the differential GPS (DGPS) will take approximately 1 day.
- Sampling of subtidal surface sediments (0 - 10 cm) using the van Veen grab sampler is anticipated to take up to 2 days based on the field logs from the 2011 sampling. Mobilization and demobilization is included in this estimate.
- Through-cap coring is estimated to take 1 days, including mobilization.
- Core processing is estimated to take 1 day

5.0 Field Activities

This section details the activities, procedures, and data quality objectives for the field sampling efforts for Year 22 monitoring at the EHOU. General descriptions of how each monitoring tool works, and its relationship to the overall program is provided below. Definitions for the quality assurance parameters (precision, accuracy, representativeness, completeness, and comparability) are given in Section 8.0 of the AQAP.

All field activities must be conducted in accordance with the site HSP.

5.1 Site Elevation Surveys

Field collections for the site elevation surveys of the EBS and West Beach will be conducted by MCA and its subcontractors. The elevation surveys consist of intertidal and supratidal topographic surveys and subtidal bathymetric surveys. The specifications and methodologies for the field sampling or data collection portions of these surveys may be found in Appendix B, *Scope of Work for Topographic Surveying of the Wyckoff/Eagle Harbor Site.*

The topographic surveys will be conducted using a combination of airborne lidar data acquired during a period of low tide, and a bathymetric survey conducted during a high tide period. In addition, digital orthoimagery will be prepared to show current site conditions. The mapping limits and control locations are shown on Figure 2 in Appendix B.

5.1.1 Upland Topographic Survey

The LIDAR data will be acquired at an altitude of 1,500 m or lower using a 50 percent lateral overlap approach to achieve a minimum density of 8 points per square meter. These parameters have been shown to result in point data with a vertical RMSE of ≤10 cm.

Multi-spectral aerial imagery will be acquired using a gyroscopically stabilized Vexcel UltraCam Falcon precision digital imaging sensor at a nominal resolution of 0.15 feet. The stereo imagery and project elevation data will be utilized to prepare natural color orthoimagery with a ground sample distance of 0.2 feet.

5.1.2 Bathymetric Survey

For the Year 22 monitoring, both single beam sonar and multibeam sonar data will be collected. The single beam is necessary to compare the 2016 data to the 2011 data, and the 2008 post-construction EBS “as-built” data consistent with what was completed in the Year 16 monitoring report. Moving forward, future bathymetric surveys at the EHOU will be done with multibeam sonar; the co-collected single beam and multibeam data will be used to inform future assessments of the data differences between the two methods.

The bathymetric data collection will be completed using TerraSond’s vessel Ospika. The crew will consist of one vessel captain and one surveyor. The survey area will be from the +4 ft. mean lower low water (MLLW) contour at the inshore limit to the project area extents. The survey vessel is a shallow draft jet boat that will be trailered to Bainbridge and launched near the project area. The survey will be planned during a high tide to enable survey to the maximum practical shoreline elevation. All standard survey quality control checks will be performed prior to, and during data acquisition.

Single beam data acquisition will consist of grid, run at a spacing matching that used in the 2008 and 2011 surveys. The survey extents will be limited to the outlined area indicated in Figure 3 in Appendix B. Multibeam data acquisition will consist of 100% coverage below the 4-foot elevation within the highlighted survey area in Appendix B, Figure 1.

QPS Quality Integrated Navigation System (QINSy) data acquisition software will be used for data collection. The software generates a real-time, corrected coverage map and survey line spacing is adjusted in real time. Line spacing is variable depending on the depths, and more or less runs parallel with the contours. Generally, the survey lines will be run with spacing such that overlap between adjacent lines is achieved at a 45-degree swath angle.

Prior to and during data collection, a series of quality assurance checks will be conducted to verify the sounding accuracies. These are detailed in Appendix B. The results of the quality control checks will be included in the final survey report.

5.1.3 Elevation Data Processing

MCA data deliverables are defined in Appendix B. Final elevation survey data will be received from both surveys as XYZ ASCII format: latitude, longitude, and elevation. Final horizontal positions will be referenced to the Washington Coordinate System, North Zone, NAD 83/91. Final vertical positions will be referenced to both the North American Vertical Datum (NAVD) 88 (Geiod 03) and NOS MLLW, Tidal Epoch 1983-2001. The unit of measurement will be the U.S. Survey Foot.

All topographic data will be plotted onto the 2016 aerial image in “as recorded” condition in order to evaluate: (1) intertidal overlap of the lidar elevation data with the single-beam data; (2) overlap of the lidar elevation data with the multi-beam data, and (3) comparability of the single-beam and the multi-beam elevation data.

All elevation data will be post-processed into site contours following the same procedures used to create the contour figures and the elevation difference figures in the 2011 report (see Figures 3-1 and 3-5 in the Year 16 Monitoring Report). The survey team will work in close coordination with Mr. David Michalsen of the Corps who processed the 2011 data.

5.2 Sediment Sampling Navigation and Positioning

5.2.1 Rationale

Precise navigation and positioning is required to document the locations where samples were acquired and to occupy and reoccupy sampling locations from previous investigations and monitoring activities. Accurate and precise positioning is a required quality control parameter for all objectives. Detailed procedures for navigation and positioning are described below.

5.2.1.1 Method

A DGPS will be used to navigate to, occupy, and document all over water stations aboard the *R/V Nancy Ann* operated by MSS. A Trimble AG 132 DGPS utilizing the U.S. Coast Guard differential signal from Oak Harbor, Washington, will be interfaced to a computer running software enabling real-time plan view navigation to the required sampling stations. Station coordinates will be digitally recorded and in the field logs at the time of collection of each sample in North American Datum 1983 (NAD 83).

Navigation and positioning will be accomplished using a submeter accuracy DGPS utilizing the Coast Guard broadcast differential correction signal. For shipboard operations, the DGPS system will be interfaced to an integrated navigation system that will use the GPS data to display the vessel position in plan-view along with a target sampling station, store the coordinates of target sampling locations, and record coordinates of sample acquisition. For intertidal sampling, a backpack DGPS will be used, with target sampling locations entered in the DGPS prior to sampling. The positioning system must be able to provide highly accurate positions (±2 meters in real-time) with a rapid positional update (e.g., every 3 seconds or less). The methods and QA/QC procedures described herein are applicable to all surveys.

5.2.1.2 Study Area Definition

The survey area is similar to that surveyed during previous monitoring events but now also encompasses North Shoal Subtidal area. The study area is shown in Figure FSP-2.

5.2.2 Procedures

5.2.2.1 Equipment

The following equipment is required for operation of the navigation system:

Differential Global Positioning System

- Sub-meter GPS unit(s)
- VHS NMEA Differential Receiver
- GPS and VHS Antennae

Integrated Navigation System Components

- PC-based Computer System Including Monitor
- Printer/Plotter
- Navigation software

5.2.2.2 Survey Setup

The integrated navigation system is controlled through a series of menu-driven options and presents a visual display of the ship's position relative to the intended destination. Before a survey begins, a file is created containing the horizontal control check point coordinates, sampling points (waypoints), survey parameters, chart parameters, and data recording parameters. Eagle Harbor surveys have used state plane coordinates (X and Y) and the 1927 North American Datum (NAD 27) in 1994, and NAD 83/WGS-84 datum with geographic coordinates in subsequent surveys. The survey will be conducted utilizing GPS, which operates in the WGS-84 or NAD 83 datum.

5.2.2.3 Data Quality Objectives, Instrument Calibration, and Quality Control Procedures

The Data Quality Objective (DQO) for navigation is precision placement with an accuracy of ± 2 m for a minimum completeness of 100 percent of all sampling stations. To meet these parameters, the instrument quality control procedures described below will be followed.

A location of known position (horizontal control check point) will be visited by the survey vessel prior to the start of each survey day to ensure that the positioning system is operating satisfactorily. Horizontal control points previously used at the EHOU are listed in Table FSP-4. A record of the daily "navigation check" will be kept in the field log.

Precision navigation and positioning are critical to successful completion of this program. To ensure that the DQO of ±2 meters is satisfied, the following institutional controls will be implemented:

- Setup procedures for the navigation system will be established and followed aboard the research vessel to ensure that the antennae are always in the exactly same location.
- To verify accurate horizontal control, a known position will be occupied daily, prior to survey operations. A log will be kept of the daily fixes to identify any errors in the navigation system.
- Before field operations, the navigator will check the system's hardware and software to make sure the computer, peripherals, and diskettes are functional.
- A proper supply of electronic and mechanical spares will be maintained on shore and aboard the research vessel to insure minimal down-time.

5.2.2.4 Real-time Data Collection and Display

The GPS unit calculates the vessel’s position using the satellite signal time delays and the broadcast differential correction. The integrated navigation system displays the vessel’s position in plan-view relative to a target sampling position, or waypoint. Target sampling locations for surface sediment collections and through-cap core collections will be loaded into the shipboard integrated navigation system prior to the start of the survey and retrieved and displayed throughout the survey. Once the research vessel is piloted to within a specified distance from the target sampling location, data will be collected, including a fix of vessel position at the moment of sample acquisition. This fix will be recorded digitally and in the project field log.

5.2.2.5 Data Processing

Records of sampling locations will be maintained and reported in geographic (latitude and longitude) NAD 83 coordinates. The integrated navigation system will be used to display and record position data, however, all coordinate conversions and geographic data processing will be accomplished using Corpscon and ArcView®, respectively.

5.2.2.6 Data Reporting

Navigation deliverables consist of listings of proposed and actual sampling locations for sediment sampling, sediment coring, intertidal sediment sampling, and clam tissue collections. QA deliverables include daily horizontal control check points.

5.3 Surface Sediment Sampling

5.3.1 Rationale

Subtidal surface sediment samples, representing sediments 0-10 cm below mudline, will be collected from the subtidal cap (Grids J9 and J10), and from the North Shoal subtidal area locations (Grids J7, J8, K8 and L8). Surface sediment samples will be collected to assess the chemical character of surface sediments with respect to SMS and/or the Eagle Harbor Site Sediment Criteria (Tables PMP-5 through PMP-6). All subtidal samples will be compared to the SMS criteria. Shallow core samples (0 to 2 feet deep) will be collected at the EBS/West Beach sample locations and the results will be compared to the Site Sediment Criteria. The objectives and rationale for surface sediment sampling are defined in the 2016 OMMP Addendum and are given in PMP Table PMP-4.

5.3.1.1 Sampling Locations

The stations where 0-10 cm surface sediment samples will be collected are listed in Table FSP-1 and are shown in Figures FSP-4 and FSP-5.

5.3.1.2 Sample Collection, Field, and Laboratory Analyses

Collection of subtidal surface sediment samples collected using a 0.25 m^2 hydraulically-driven power grab from the *R/V Nancy Anne*. Collection on the EBS will be by hand-trowel.

All site surface and shallow core sediment samples require the collection of three grab samples per grid composited to a single sample for analysis. Subtidal samples will be analyzed for total solids, total organic carbon (TOC), grain size, and the SMS-designated list of PAHs, PCP, and mercury. Composite core samples collected from the EBS and West Beach will be analyzed for total solids, TOC, grain size, PAHs, and PCP. For each collection site an individual sediment sample will be collected and archived.

The total number of surface and shallow core sediment samples and corresponding analyses to be performed are shown in Tables FSP-1 and FSP-2. More specific details on methods are described below.

5.3.1.3 QA/QC, Blank Samples, and Frequency

QA/QC for surface and shallow core sediment samples collected for chemical analyses include procedures for collecting an undisturbed sediment sample with no sampling-induced cross-contamination, evaluating the representativeness of the sediment and ensuring the accuracy of analyses. QA/QC for the collection of surface sediment samples is described in the discussion of field collection procedures.

DQOs for sediment chemical analyses require the collection of field duplicates, blanks, and equipment rinsates. A summary of QC samples required is presented in Table FSP-5. A discussion of those requirements may be found in Section 6.0 of the AQAP.

To evaluate the representativeness of the sediment samples as well as spatial heterogeneity of surface and shallow core sediments, surface sediment field duplicates will be collected from one subtidal sediment station, and an intertidal shallow core sediment station from the EBS.

To evaluate collection-related cross-contamination, equipment rinsate samples will be taken at a frequency of 5 percent, or one per sampling event, whichever is more frequent (Table FSP-5). Rinsate blanks will be distilled water rinsates taken from the decontaminated sampling devices and compositing utensils.

Matrix spikes and matrix spike duplicate (MS/MSD) analyses will be conducted on 5 percent of the samples or one per batch, whichever is more frequent (see AQAP). Sufficient sediment will be collected from each station such that the MS/MSD can be conducted on any sample. Based on the screening of extract, samples that appear to be highly contaminated will not be selected for MS/MSD due to their high probability of adverse matrix interferences and likely poor recoveries. Samples of intermediate concentration will be chosen for MS/MSD analysis based on conversations with the analytical laboratory, using best professional judgment.

5.3.2 Procedures

5.3.2.1 Equipment

The following equipment is required for conducting surface sediment sampling:

- Sampling vessel with winch (subtidal sediments)
- 0.25 m^2 hydraulically-driven power grab (subtidal sediment)

- Hand-cores/hand trowels (intertidal sediments)
- Decontaminated stainless steel sampling spoons and mixing bowls
- Solvents (isopropanol and/or hexane), distilled water, and Alconox® for cleaning sampling equipment and tools
- Ruler/measure
- Sample jars
- Labels and tape
- Ice chests
- Tygon tubing for siphoning overlying water
- Gloves and personal protection equipment (e.g., polyethylene, nitrile, solvex gloves, rain gear, steel-toed boots)
- Containers for IDW
- Field Notebooks/sampling logs
- DGPS Positioning system
- Integrated navigation system

5.3.2.2 Sampling Methods for Subtidal Surface Samples using the Power Grab

Surface grab samples (upper 10 cm) will be collected from the subtidal regions of the EHOU using the 0.25 m^2 hydraulically-driven power grab. For surface sediment samples collected with the grab, the research vessel will be piloted to within 5 m of the sampling station coordinates, the sampler deployed, lowered to the seafloor, retrieved, and then brought back on deck. Samples will be collected to minimize any disturbance to the sediments. All overlying waters will be carefully siphoned off prior to subsampling.

Surface sediments under the SMS are defined as those in the top 10 cm (0.33 ft). Sample collection procedures are as follows:

- Prior to sampling the power grab is washed with a phosphate-free detergent (e.g., Alconox), and rinsed with site water.
- Once the boat is in the general proximity of the planned sampling station, the power grab is lowered through the water column until just above the sediment surface. The boat is positioned to within ± 3 ft of the designated target coordinates for the specific station, and the power grab is set on the sediment surface.
- The jaws of the sampler are closed, and at that time, the station name, latitude/ longitude, time of collection, and depth to mudline are noted in the field log.
- Retrieval of the grab should initially occur no faster than 1 foot per second.
- When the grab sampler approaches the water surface, the winch should be stopped, and any handling lines in use should be attached to the winch cable to reduce swinging of the grab.
- The winch should then be restarted to slowly bring the grab into the boat with minimal swinging. The grab sampler should be secured as soon as possible once it has been retrieved into the boat.

After the power grab has been secured, the upper access doors of the sampler should be opened, and the sediment sample should be inspected carefully before being accepted. The following acceptability criteria should be satisfied:

- The jaws of the sampler will be fully closed; there is no protruding rock, branches, or other debris that prevented a clean and complete closure.
- Sediment is not extruded from the upper face of the sampler (i.e., the sediment sample is not overflowing through the screens and flaps at the top of the sampler).
- Overlying water is present (an indication of minimal leakage).
- The sediment surface is relatively flat and appears undisturbed, which indicates minimal disturbance or loss of sample (winnowing).
- The entire surface of the sample is included in the sampler.

If a sample does not meet one or more of the above acceptability criteria, it should be rejected, and the sampling station should be resampled. If the sample is acceptable, the following observations should be noted in a field log or notebook before sediment is removed and placed into sample collection containers for subsequent shipment to a laboratory.

- Station location
- Time of collection
- Latitude and longitude
- Depth to mudline
- Depth of penetration (cm)
- Gross characteristics of the sediment
    - Texture
    - Color
    - Biological observations (e.g., live organisms, shells, tubes, plant material)
    - Presence of debris (e.g., wood chips or fibers, man-made debris or trash)
    - Odor (e.g., hydrogen sulfide, ammonia, oil, creosote, etc.)
    - Color (Munsell scale)
    - Sheen
- Vertical profile information
    - Stratification, other changes in sediment characteristics
    - Presence and depth of redox potential discontinuity layer, if visible
- Comments regarding sample quality (leakage, disturbance, and any other pertinent observations)

After these observations have been recorded, the collected sediment can be removed from the sampler. An estimated 2 liter (L) of sediment will be required per station for chemical analyses. Additional sediment volumes would be collected for duplicate or MS/MSD analyses. Sample volume requirements are given in Table FSP-6.

Prior to collection at the next station, the sampler is rinsed with site water, washed with the phosphate-free detergent, and rinsed again with site water. Residual sediments not retained for chemical analyses, as well as equipment rinsates, will be handled as documented in the IDWP.

5.3.2.3 Sampling Methods for Shallow Core Sediment Samples using the Hand Core

For EBS and West Beach surface sediments, sampling personnel will transit by foot to sampling stations using a backpack DGPS to navigate. Once at the station, sediment will be collected by either inserting a hand-core into the sediment or through use of a shovel. Undisturbed, representative sediment will be sampled, as evidenced by lack of megafaunal burrowing or scavenging, presence of debris, or evidence of recent anthropogenic disturbance. The sampling interval at the EBS is 0 – 2 ft, or to the depth of the underlying cobble layer. For the single West Beach sample not on the EBS (grid D12), the depth of sampling is 2 ft or refusal, whichever comes first.

The same sample observations noted above will be recorded in a field log or notebook before sediment is removed and placed into sample collection containers for subsequent shipment to a laboratory.

5.3.2.4 Sample Compositing and Homogenization

For all subtidal sampling locations, a single sample (1000 mL, 16 oz) will be taken from each successful grab sample, prior to subsampling for the composite sample. The sediment will be spooned directly into a jar labelled for the sampling location, with a label affixed clearly indicating it is an individual site archive sample.

After securing the single site subtidal archive sample, sediment will be secured from the desired depth interval, away from the sides of the grab, and transferred to a pre-cleaned stainless steel bowl for compositing. Approximately 1.5 L of sediment will be required from each station for physical and chemical analyses. Sample volume and holding requirements are given in Table FSP-6.

A similar approach will be used for compositing of the EBS/West Beach shallow core samples. However, archive volumes will not be collected from each discrete sample location unless visual or olfactory observations at the time of sample collection indicate that additional volume should be held in reserve for additional analysis. A similar volume (i.e., 1.5 L) of sediment will also be required from each EBS/West Beach station for planned analysis.

During sample preparation, non-representative material (e.g., debris) will be removed from the sample at the direction of the chief scientist. Until all grab samples have been collected at a given station, the bowl will be covered with aluminum foil, and protected from direct light. Samples will be homogenized by mixing with a stainless steel spoon until uniform consistency and color are achieved.

5.3.2.5 Sampling for Physical Analyses

Sample volumes and container requirements are given in Table FSP-6. Volumes collected will be sufficient for the laboratory to run all quality assurance analyses as required by the AQAP.

For grain size analysis, approximately 500 mL of the homogenized sediment will be transferred to either a glass or plastic jar, using a decontaminated stainless steel spoon. The appropriate sample label will be completed, attached, and taped to the sample container. The sample container will then be placed in a zippered bag, and kept on ice at approximately 4ºC until transfer to the laboratory. Appropriate transfer procedures are discussed in Section 6.

5.3.2.6 Sampling for Chemical Analyses

For TOC analysis, approximately 125 mL of sediment will be transferred into a glass jar fitted with a Teflon liner. The sample label will be completed and affixed, and the jar will be bagged and kept on ice until transfer to the laboratory.

For sediment organic (i.e., PAH) analysis by method 8270D, a minimum of 250 mL of homogenate will be transferred into a glass jar with a Teflon-lined lid. Care will be taken to assure that the inside of the bottle, cap, and sample are not cross-contaminated during transfer. For TPH analyses, 250 ml of homogenate will be placed in a pre-cleaned glass jar. Samples will be labeled, bagged, and kept on ice until transfer to the analytical laboratory. In addition, 500 ml of sediment homogenate will be collected and archived.

5.3.2.7 Sample Containers and Storage Techniques

After sample preparation (e.g., compositing), the samples will be processed and shipped according to sample handling and custody procedures described in Sections 5 and 6. Maximum holding times are listed in Table FSP-6.

5.3.2.8 Field Quality Control Sampling Procedures

Field quality control samples and field duplicates will be collected at stations where duplicate analyses are required. For the previously designated field duplicate stations, QA samples for the chemical analyses will be collected from the same composite.

For equipment rinsate blanks, 2 L of distilled water will be poured into and through the decontaminated sampler and collected into a decontaminated stainless steel bowl. Any tools used in the sediment transfer process (e.g., spoons) will also be placed into the bowl and water. The water will then be transferred into 1 liter glass bottles, labeled, and processed as described above.

5.3.2.9 Decontamination Procedures

Sediment collection and compositing equipment will be decontaminated prior to initiation of sampling and between sampling locations. Decontamination methods are consistent with PSEP (1989a and 1989b); the following procedures will be used for all subsampling equipment (e.g., stainless steel bowls and utensils) decontamination:

- Clean with site water and non-phosphate detergent; use a brush to remove particulate matter
- Rinse thoroughly with site water
- Rinse with 1N nitric acid
- Rinse with deionized water
- Rinse with isopropyl alcohol
- Rinse thoroughly with deionized water
- Air dry

Decontamination fluids will be handled according to the IDWP. If visible creosote is observed on the sampler, decontamination will also include hexane; hexane is more efficient in removing petroleum-based residue than methanol. Decontamination rinsates will be collected for appropriate disposal as outlined in the IDWP.

5.4 Through-cap Cores

5.4.1 Rationale

On-cap sediment core sampling in the Year 22 monitoring will only be completed in off cap areas of the North Shoal subtidal area. These cores, collected to 6 ft or refusal, whichever comes first, will be visually evaluated for the presence or absence of NAPL, sandy cap material, and debris. The collected cores will be photographed and logged only; no sediment will be collected for chemical analyses.

5.4.1.1 Sampling Locations and Collection

Sampling locations are only in North Shoal subtidal area locations. Station locations for sampling are given in Table FSP-1, and are shown in Figure FSP-5. The objective is to obtain representative core samples down to 6 ft below mud surface (bms). Cores will be examined, photographed and logged as described in the following sections.

5.4.2 Procedures

5.4.2.1 Equipment

The following equipment is necessary to collect sediment cores:

- Research Vessel with winch
- Vibracore and core barrels
    - Vibracore with 4-inch-diameter aluminum tubes (8 ft length)
    - Sediment coring log form and field logs
    - Pre-cleaned sample containers and labels
    - Processing table and supplies (e.g., gloves, foil, coolers, plastic drop cloth)
    - Core sectioning equipment (pipe cutters, saw, caps)
    - Decontamination materials and buckets
    - Aluminum trays or foil and rubber mallets
    - Engineering measuring tape
    - Core sample holders
    - Camera for photo documentation
- DGPS
- Integrated Navigation System

5.4.2.2 Sampling Methods for Subsurface Coring

Positioning of the research vessel and vibracore unit will be the same as that described for collecting surface sediment samples. The sediment core procedure includes the following:

- All data from sediment core collection is recorded real-time onto field logs.
- The sampling vessel is maneuvered to the designated target coordinates for dredge prism stations using the DGPS and an on-board navigation system.
- Prior to occupying a sampling station a pre-cleaned aluminum core barrel fit with a core-catcher is set into the vibracore apparatus.

- Once the boat is in the general proximity of the planned sampling station, the coring apparatus is lowered vertically through the water column till just above the sediment surface. The boat is positioned to within ± 3 ft of the designated target coordinates for dredge prism stations, and the core unit is set on the sediment surface.
- The vibracore unit is switched on, and the progress of the cores descent through the mud is monitored for achievement of the target push depth (6 ft) or refusal.
- For each core attempt, the station name, latitude/longitude, time of collection, depth to mudline, depth of drive, and total drive time are noted in the field log.
- The core apparatus is retrieved and brought back on board. The field crew will note the condition (texture, color, presence of debris) of the material in the bottom of the core, and then fix a plastic cap over the tube to retain material prior to removing the tube for cutting.
- The amount of material retained in the core tube is measured and recorded in the field log. The recovery depth is the total length of tube penetration minus the measured depth from the top of the tube to the height of the mud in the tube.
- Compare the length of the recovered core to the station core penetration depth. If the length of the core is less than 60 percent of the core penetration depth, discard the core:
- If the core is discarded, make an additional attempt at least 1 foot from the previous location.
  - If the second attempt fails, determine if there is a physical reason (e.g., sediment type) that is preventing adequate recovery.
  - A maximum of three attempts will be made.
  - If the third attempt fails the recovery criteria, the core is retained, and in consultation with the USACE and EPA determine if the core should be processed and analyzed.
- The retained core tube is placed into an on-board cutting jig, measured and marked (scoring the metal) in 4 ft intervals. Each interval is marked with the station name, the core interval (i.e., A, B, or C) and the direction to the top of the core. Once cut, the scored labels may be written over with a permanent marker.
- The tubes are cut and capped, with the cap being secured with duct tape. The station, date, time, interval, and a direction arrow to the top of the tube are made with a permanent marker on the duct-taped cap.
- The cut and marked core intervals are stored vertically in a core rack, on ice, and in the dark (e.g., under a tarp) till processing.

The actual depth of sediment inside the core tube (sample recovered) may be less than the core tube's penetration into the harbor bottom, depending on the degree of compaction and loss of sample out the bottom of the tube. In soft fine-grained sediments, typical sample recoveries using this sampler range from 75 to 85 percent of the penetration depth. As the cap is composed of coarser-grained materials, recoveries may be lower. The sample tube will be removed and handled as described in the following sections. Penetration of the core barrel into the sediments will be monitored using a transducer at core head. Rate of penetration will be recorded in the core acquisition log.

5.4.2.3 Field Measurement Procedures

All information concerning the collection of cores will be entered in a field notebook. At a minimum, this will include station, date, time of collection, depth of core, rate of penetration, visual or olfactory evidence of chemicals of concern (COC), and any other features that may affect the quality of data.

For Year 22 monitoring, cores will be collected in a 4-inch inner diameter decontaminated aluminum core tube. A continuous core sample, up to 6 feet in length, will be collected. Once retrieved, acquisition will be determined by measuring the amount of sediment within the core tube. Percent recovery will be recorded as recovery length/drive length times 100. Once measured, the core will be cut into a single 6-foot length for transport to the processing laboratory. The core ends will be covered with aluminum foil and capped to prevent leakage of porewater. Any water overlying the core will be siphoned or drained prior to cutting into the 6-foot segment. Each core will be labeled with station name, replicate, time, date and interval below mudline.

5.4.2.4 Sample Logging

Core exposure, photographic and logging will occur in at ARI. Core segments will be processed by scoring each core segment lengthwise and then splitting the tube and exposing the sediment. All processing will occur on a foil-covered processing table. Each core will be logged with time, date, personnel, sediment type, stratigraphic features and the presence or absence of any visible contamination recorded in the core log. In addition, photographs of each core segment will be taken. Each core photograph will also include a label denoting station, replicate, time and date along with a scale. Each core will be examined by the Senior Sediment Scientist, and those observations will be recorded in a sediment coring log (Figure FSP-7).

5.5 Clam Tissue Collection

5.5.1 Rationale

Clam tissue residue analyses will be conducted to provide information to on PAH body burdens in clams on the beaches adjacent to the Wyckoff site. The tissue chemistry data may be used in a future human health risk assessment, future trends analysis, and for assessment of natural recovery.

Clam tissue sampling will be conducted by the USACE under a separate QAPP (Appendix A). Elements of that plan salient to this FSP are discussed briefly here.

5.5.2 Sampling Locations

For the Year 22 monitoring, the 2016 OMMP stated that clam tissue is to be sampled at the EBS, the Intertidal Cap, North Shoal, and the East Beach. The actual sampling locations for clam tissues would be dependent on clam density and presence of the target species (*Protothaca staminea*). The Clam Tissue QAPP (Appendix A) the USACE references the 2014 QAPP and states that only horse clams of harvestable size will be collected from intertidal areas at the site – Intertidal Beach, North Shoal, East Beach, and West Beach.

5.5.3 Survey Schedule

Collection of clam tissue samples at the EHOU occurred in July 2016. The sampling of clam tissue occurred ahead of the Work Plan in order to characterize the clam tissues at a time period where lipid content is highest.

5.5.4 Survey Methods

Specific survey methods and analytical methods are documented in Appendix A. Clams were not collected on a grid system as the objective was to collect enough clams for tissue analysis within the separate locations. The general collection sites were GPS-located rather than at each specific hole from which clams were collected. A new GPS reading was taken for all sample locations on West Beach, North Shoal, East Beach, and Intertidal Cap. All clams were placed in coolers with ice in accordance with the QAPP and were hand delivered to EPA's Manchester Laboratory under chain of custody at the end of the collection day for analysis of PAHs and lipids.

5.5.5 Reporting

Reporting of the clam tissue data will consist of tabular summaries of PAH and lipid content by station. All data will be validated, however no interpretive discussion of the clam tissue PAH and lipid concentration data will be provided.

6.0 Sample Activity Documentation/Chain of Custody Procedures

This section describes procedures for maintaining sample control through field, sample, and shipping documentation. This section is intended to cover all activities from collection through to receipt of the samples by the lab, or placing of field records into the final evidence file.

6.1 Field Logbook

A bound, water resistant field notebook (with numbered pages) will be maintained throughout collection activities by each field team leader (sampling and sample processing) to provide a daily record of events, observations, and measurements during field investigations. Station and sample log sheets will also be completed by the site representative. All entries will be signed and dated. All other participants in the field investigation will use these notebooks and field forms which will be kept as a permanent record. Any inadvertent entries or mistakes in the log book will be crossed out and initialized by the recorder (refer to Section 6.5).

The notebooks and field forms are intended to provide sufficient data and observations to permit reconstruction of events that occurred during the project.

The following information will be documented in the field notebooks:

- Name and title of author, date, and time of entry
- Names and responsibilities of other team members on-site
- Names and titles of any site visitors
- Project name and location
- Purpose of sampling activity
- Material to be sampled
- Site safety meeting (if applicable)
- Levels of personnel protection (if applicable): level of protection originally used, changes in protection if required, reason for changes
- Documentation on samples taken: date, time, location (and depth), type of sample, sample identification numbers, sample matrix, analyses required, sample characteristics and description (i.e., cloudy water, approximate grain size for classification of sediment), readings taken (if any)
- Equipment utilized
- Project samples and QA samples: know where they are to be sent, date they are sent, air bill (if not hand delivered)
- On-site measurement data/parameters/instruments (if any)
- Field observations and remarks
- Weather conditions

- Unusual circumstances or difficulties and resolutions
- Photographs taken
- Deviations to the approved 2016 OMMP Addendums and/or FSP
- Chain-of-custody record numbers
- Investigation-derived wastes, such as contents and approximate volume of waste, disposal method, type and predicted level of contamination
- Signature and date (entered by personnel responsible for observations) at close of field day operations

All original data recorded in field notebooks, sample identification numbers, chain-of-custody records, and receipt-for-sampling forms will be written with waterproof ink. None of these accounted, serialized documents will be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document.

6.2 Photographs

Photographic records are an important component of the surface sediment coring components of Year 22 monitoring. Additional photographs of field conditions, collection activities, or general conditions will be made during the field activities.

Photographs of field activities will be taken. At a minimum, one representative photograph of each field activity will be taken (e.g., cap surface sediment sampling, through-cap coring, intertidal cap surface sediment sampling, etc.). To the extent practicable, photographs of the EBS and West Beach sampling locations will also be collected as part of the sampling program. These photographs will include a label stating station identification, time, date and scale.

Photographs of North Shoal subtidal area cores will be taken. These photographs will document stratigraphy and support subsampling and compositing decisions.

All photographs taken during the collection and processing of surface and subsurface sediments will be submitted as an appendix in the draft and final monitoring reports.

6.3 Sample Numbering System

All samples collected during Year 22 monitoring will be identified with a two part sample numbering system: the sample tracking number and the “blind” laboratory number. The sample tracking number contains information about the sample linking it to location collected, time collected and the strata collected. A blind numeric sample number will also be generated for labeling the samples sent to laboratory. The numbering system is the same as that used in the 2002 Year 8 monitoring (EPA 2004).

The same sample numbering strategy as past surveys will be used in this monitoring effort to maintain programmatic consistency. For the sample tracking number, information regarding the media collected, the site, the station location, the sequence of samples collected from a station (i.e., more than one sample may be collected from a core), date sampled, and the stratigraphic interval at which the sediments were sampled.

Media - The media of the sample collected will be designated using two letters. For this 2016

Year 22 monitoring, three options are available: sediment (SS), water/rinse (WR) samples, and tissue (TI) samples.

Site - For the Year 22 monitoring program only one option is available, "EH," which stands for EHOU.

Location - These are the grid cell station identifiers (Table FSP-1; i.e., I-9, J-10).

Sequence - A sequential number given to a sample at a specific location on a given sampling date.

Date - The date on which the specific sample was collected.

Interval - The depth of the strata sampled measured downward from the mudline, in centimeters (i.e., a sample taken in the top 10 cm of the sediment column would be designated 0.10, with mudline being 0 cm and 10 cm being the lower limit of sample acquisition).

An example of the sample numbering system is given below. The sample identification shows that this is the top section (0 - 10 cm) of a sediment sample collected at station G-8 on 14 January 2017 and is the first sample collected at this station.

This would equate to a sample identification number of SS EH G-8 001 14012017 .10 (media:site:station:sequence:date:strata).

To ensure that the field samples are delivered "blind' to the laboratory, all sample containers will be labeled using only the calendar date with a sequentially assigned number on the day of sampling. For example:

Blind I.D.	**011417001**
011417	Sample collected on January 14, 2017 (01/14/2017)
001	The first sample collected on January 14, 2017

Both the field and the blind identifications must be entered into the field log book. An example record would read:

SS EH G-8 0001 0142017 .10 = 011417001

6.4 Sample Documentation

Sample documentation refers to tracking procedures that begin with sample labeling, and continue until the conclusion of analysis and the sample is destroyed.

6.4.1 Sample Labels

All samples must have properly affixed labels prior to packing and shipment to the laboratory. Information must be legibly written in indelible ink and include at a minimum the following information:

- Project Name
- Project Number
- Blind Sample Identification Number Sampler's Initials
- Preservatives (if used)
- Required Analysis

- Date and Time of Collection
- Type of Sample (sediment, rinsate water)

Prior to packing, the field scientists should check to ensure that both the lab sample identification number and the field sample identification number are recorded in the field log book, and that those numbers match on the sample label.

The label is affixed to the sample container, and wrapped with a layer of clear packing type to ensure the labels do not come off.

6.4.2 Chain-of-Custody Records

Verifiable sample custody is an integral part of all field and laboratory operations associated with this field investigation. The primary purpose of the chain-of-custody (CoC) procedures is to document the possession of the samples from collection, through storage and analysis, to reporting. CoC forms will become the permanent records of sample handling and shipment.

Field sampling personnel are responsible for the care and security of samples from the time the samples are collected until they have been turned over to the shipping agent or laboratory. A sample is considered to be in one's custody if it is in plain view at all times, in the physical possession of the sampler, or stored in a locked place where tampering is prevented.

Empty coolers containing ice or ice substitute will be available at the study area for use each day in the field. Samples collected during the day will be stored in these coolers beginning at the time of collection. The coolers will be locked inside the field vehicle or other secure location when sampling personnel are not present.

A CoC form will be filled out for samples in each cooler. An example CoC is provided in Appendix C. Each CoC form will contain the following information:

- Sample identification numbers
- Date and time of sampling
- Type of sample and number of sample containers associated with each sampling point
- Total number of sample containers in cooler
- Unique cooler identification number
- List of analyses requested
- Name and signature of sampling personnel
- Shipping airbill number, when applicable
- Comments regarding MS/MSD samples or any other information that is necessary for the laboratory
- Space for transfer of custody acknowledgment

When the CoC form is complete, field team members will cross-check the form. If samples are repackaged for shipping or delivery, one team member will cross-check the CoC form with the samples that are packed while another team member packages the samples. Corrections will be made to each record with a single strike mark that is dated and initialed. The person who initials corrections will be the same person who relinquishes custody of the samples. The CoC forms will be signed and dated, placed in resealable plastic bags, and taped to the inside lid of the respective coolers. Copies of the completed chains of custody will be retained by the field crew and one copy will be provided to USACE.

6.4.3 Receipt of Samples

All samples will be hand delivered to the analytical laboratories, EPA Manchester Laboratory (clam tissue only) and ARI, Tukwila, Washington. Upon delivery, the field scientist and the EPA and ARI sample custodians will review and transfer the custody forms. A copy of the signed form will be given to the SEE scientist and filed in the permanent evidence file. A cooler receipt form will also be filled out by EPA and ARI upon receipt of the samples and will become part of the permanent record files. Receipt of sample procedures by EPA and ARI are described in Section 4.3 of the AQAP.

6.5 Corrections to Documentation

When an error is made on an accountable document, corrections may be made by first placing a *single line* through the error, initialing and dating the lined-out item, and entering the correct information. The erroneous information must not be obliterated. Any subsequent error discovered on an accountable document should be corrected by the person who made the entry. All subsequent corrections must be initialed and dated.

6.6 Data Storage and Security

All documents generated during field and lab activities will be placed in the permanent evidence files, and stored in locked, fire-proof cabinets. Access to these records is controlled by the HDR project manager, and will be restricted to authorized personnel working on the project.

Data transferred to electronic media will be copied onto back-up discs and along with a hard copy of those data records, stored with the permanent record files. Users of the computerized data are prohibited from altering the data in electronic records through user-entry restrictions built into the computer software. Where electronic data are required for technical report generation, users will be given either read-only access, or copies of those files.

7.0 Sample Packaging and Shipping

This section outlines the procedures necessary for properly packaging and shipping of environmental samples to be sent to the lab. The procedures outlined below are performed after samples have been collected and placed in proper containers and correctly preserved.

7.1 Sample Container Preparation

Following sample collection and filling of sample jars, the following procedures are followed to prepare sample containers for shipping:

- The outer surfaces of all sample containers are wiped down with disposable towels to remove any adhering mud or sediment. Distilled water may be used to rinse the jars, if necessary.
- All sample labels should be clearly filled out following procedures described in see Section 6.4.1. Labels will be affixed to each sample jar and taped.
- The master sample log/chain-of-custody form is completed following procedures outlined in Section 6.4.2. Each sample jar is verified against the chain-of-custody form to ensure that the intended analyses are to be conducted and the correct sample jars are prepared.
- Each sample jar is placed in a plastic zippered bag, and the bag is sealed. As much air as possible is squeezed from the bag before sealing.

7.2 Sample Packaging

All sample containers will be placed in a strong shipping container, such as a metal or plastic picnic cooler with a hard plastic liner. The shipping container should be sufficient to prevent leaks or spills of ice water or broken sample containers. The shipping container will be adequately cleaned between shipments to prevent cross-contamination of samples. The following procedures will be used to pack samples for shipping:

- Samples are transported using insulated, rigid ice chests (coolers). The drain plug is secured shut using duct tape or strapping tape.
- Glass sample containers are wrapped with plastic insulating material (bubble wrap) to prevent contact with other sample containers or the inner walls of the cooler. Additional packing material will be placed above and below the sample containers. Adequate ice or blue ice is dispersed in the cooler to ensure that the samples maintain a temperature of 4°C until delivery to the lab.
- If samples contain potentially hazardous materials, the cooler is lined with absorbent packing for liquids and Styrofoam packing for solids (49 Code of Federal Regulations 171,172,173). The cooler will also be lined with a large plastic bag and sealed over the top of the sample containers.
- Once the cooler is properly filled, the completed chain-of-custody form is sealed in a Ziploc plastic bag and taped to the inside cover of the ice chest.
- The cooler is closed and sealed with duct tape or strapping tape. Prior to shipment, two custody seals are placed on the cooler, one on the front and one on the side. Each custody seal is signed and dated.

- An address label is affixed to the cooler. A "This Side Up" sticker is placed on the cooler and "Fragile" labels on two sides and the top of the cooler.

7.2.1 Shipping

Transfer of samples from the project site to the project analytical laboratory is expected to be performed by field personnel or via an overnight courier service. Deliveries must be arranged with the laboratory before samples are shipped. Deliveries may be shipped directly to the laboratory or to the courier's office for pickup by laboratory personnel.

All chemical analyses of sediment samples will be performed by ARI in Tukwila, Washington. The laboratory project manager and contract information are as follows:

> ARI Laboratory Project Manager Cheronne Oreiro
> 4611 S 134th Place # 100
> Tukwila, WA 98168-3212
> Phone: (206) 695-6214

8.0 Investigation-Derived Wastes

A separate IDWP has been developed to provide specific waste generation and handling protocols for the field sampling and analytical programs in accordance with guidance presented in EPA's Management of Investigations-Derived Wastes during Site Inspection (EPA 1992). The complete IDWP is a companion document to this FSP. Disposal of field-generated wastes, including sampled sediments, field supplies, and decontamination fluids, must conform to the requirements of the IDWP.

9.0 Field Data Management, Validation, and Corrective Actions

9.1 Field Data Management

All field measurements and observations recorded in project log books, on field data forms, or on similar permanent records by field technicians, are to become part of the permanent evidence file. Field data is to be recorded directly and legibly in the logbooks or forms, with all entries signed and dated.

Managerial documentation consists of:

- Data processing and storage records
- Sample identification and chain-of-custody records
- Field changes and variances
- Document control, inventory, and filing records
- QA/QC records
- Health and safety records
- Financial and project tracking records.

9.2 Field Data Evaluation

The purpose of data evaluation is to ensure that defensible and justifiable data are obtained. To that end, reviews will be judged against the following:

- Stated objectives of the 2016 OMMP Addendum
- Proper execution of the procedures defined in the FSP
- Equipment and instruments properly calibrated and in working order
- Samples/data collected according to the FSP
- Adequate documentation and justification of deviations from the FSP
- Sufficient sample volume collected to maintain sample integrity, conduct all analyses and yet minimize investigation derived waste
- All applicable field QC samples collected and provided to the laboratory
- Completed and accurate chain-of-custody documentation kept throughout sample transfer
- Field samples arrive at the laboratory in good condition.

Initial responsibility for verification of accurate entries will lay with the field data logger. At the end of the sampling day, the data logger must sign and date the log book. The SEE sediment technical lead will then verify data to ensure that all pertinent information has been entered and that correct codes and units have been used. The sediment technical lead will direct the field data logger to make any necessary corrections to the record, and initial them (refer to Section 6.5). The sediment technical lead will then sign the records to indicate that he/she has reviewed them.

When the data is returned to the office at the end of a specific phase of field operations (e.g., acoustic surveys), the sediment technical lead (Section 3.2) or a designated representative will review the data for representativeness, accuracy, and comparability with other data collected. The sediment technical lead will direct the responsible field personnel to make necessary correction to the record, and initial them. The sediment technical lead will then sign the records to indicate that he/she has reviewed them.

After data reduction into tables or arrays, the sediment technical lead and his associate will review data sets for anomalous values. Any inconsistencies will be resolved by seeking clarification from the field personnel responsible for data collection.

Managerial and technical data will be verified by the project manager for reasonableness and completeness. The sediment technical lead and his associate will make random checks of sampling and field conditions. The designated QA officer will review selected field data and procedures during random site visits to ensure adherence to the FSP and AQAP. Whenever possible, peer review will also be incorporated into the data evaluation process in order to maximize consistency among field personnel. All data evaluation will be verified by a dated signature.

9.3 Corrective Actions

The purpose of the evaluation process is to qualify or eliminate field information or samples that were not collected or documented in accordance with specified protocols outlined in the FSP/AQAP. Corrective actions for field methods were discussed in Section 6.5. If a problem occurs which might jeopardize the integrity of the project or cause quality assurance objectives not to be met, corrective measures will be determined and discussed among the HDR project manager, the USACE, and EPA. Once a course of action has been determined, it will be documented on a field change request form and implemented.

Procedures may be found in Section 10.0 of the AQAP.

10.0 References

EPA. 1992. Guide to Management of Investigation-Derived Wastes. Office of Solid Waste and Emergency Response US Environmental Protection Agency. Publication No. 9345.3-03FS. January 1992.

EPA. 2004. 2002-2003 Year 8 Environmental Monitoring Report. Wyckoff/Eagle Harbor Superfund Site, East Harbor Operable Unit, Bainbridge Island, Washington. Prepared for US Environmental Protection Agency, Region 10, Seattle, Washington and the US. Army Corps of Engineers, Seattle District. Prepared by Integral Consulting and the US Army Corps of Engineers, Seattle District. August 16, 2004.

PSEP. 1989a. Puget Sound Estuary Program: Recommended guidelines for measuring organic compounds in Puget Sound sediment and tissue samples. Final report. Prepared for U.S. EPA Region 10, Office of Puget Sound, and the U.S. Army Corps of Engineers. PTI Environmental Services, Inc., Bellevue, Washington.

PSEP. 1989b. Puget Sound Estuary Program: Recommended protocols for measuring metals in Puget Sound sediment and tissue samples. Final report. Prepared for U.S. EPA Region 10, Office of Puget Sound, and the U.S. Army Corps of Engineers. PTI Environmental Services, Inc., Bellevue, Washington.

USACE. 2001. East Beach Intertidal Investigation Report. Wyckoff/Eagle Harbor Superfund Site, East Harbor Operable Unit, Bainbridge Island, Washington. U.S. Army Corps of Engineers, Seattle District.

WAC. 2010. Hydraulic Code Rules WAC 220-110.

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Table FSP - 1. Planned Sampling Grids for Year 22 (2016) Monitoring

2016 Grid Cell Station ID	Latitude	Longitude	Sampling Requirements		
			No. Discrete Surface Samples (0 to 10 cm) within Grid Cell for Composite (one analytical sample)	Discrete Suburface Cores (0 to 6 ft)	No. Discrete Shallow Core Samples (0 to 2 ft) for Composite (one analytical sample)
Subtidal Cap					
J-9					
J9-b3	47 37 5.65	122 30 12.91	3	-	-
J9-b4	47 37 4.94	122 30 12.79			
J9-c3	47 37 5.30	122 30 11.84			
J-10					
J10-b2	47 37 3.33	122 30 12.82	3	-	-
J10-b4	47 37 2.68	122 30 12.49			
J10-c2	47 37 3.38	122 30 11.87			
North Shoal Subtidal Area (Grid Cells J7, J8, K7, K8, L8)					
J-7					
J7-a2	47 37 10.85	122 30 13.57	3	1	-
J7-c5	47 37 9.38	122 30 12.23			
J7-e2	47 37 10.86	122 30 11.01			
J-8					
J8-a2	47 37 8.40	122 30 13.47	3	1	-
J8-c5	47 37 6.93	122 30 12.17			
J8-e2	47 37 8.39	122 30 10.92			
K-7					
K7-a4	47 37 9.90	122 30 10.08	3	1	-
K7-c5	47 37 9.43	122 30 8.58			
K7-e2	47 37 10.92	122 30 7.35			

Table FSP - 1. Planned Sampling Grids for Year 22 (2016) Monitoring

2016 Grid Cell Station ID	Latitude	Longitude	Sampling Requirements: No. Discrete Surface Samples (0 to 10 cm) within Grid Cell for Composite (one analytical sample)	Sampling Requirements: Discrete Suburface Cores (0 to 6 ft)	Sampling Requirements: No. Discrete Shallow Core Samples (0 to 2 ft) for Composite (one analytical sample)
K-8					
K8-a4	47 37 7.44	122 30 10.00	3	1	-
K8-c5	47 37 6.98	122 30 8.50			
K8-e2	47 37 8.45	122 30 7.29			
L-8					
L8-a4	47 37 7.49	122 30 6.35	3	1	-
L8-c5	47 37 7.01	122 30 4.86			
L8-e2	47 37 8.53	122 30 3.61			
Exposure Barrier System and West Beach					
D-12					
D12-d1	47 36 58.72	122 30 33.08	-	-	3
D11-e5	47 36 59.15	122 30 32.54			
D11-c5	47 36 59.33	122 30 33.66			
F-12					
F12-d1	47 36 58.75	122 30 25.60	-	-	3
F11-c5	47 36 59.36	122 30 26.17			
F11-e5	47 36 59.18	122 30 25.06			
H-12					
H12-a2	47 36 58.61	122 30 21.02	-	-	3
H12-a1	47 36 58.86	122 30 20.81			
H12-b2	47 36 58.46	122 30 20.02			

Table FSP - 1. Planned Sampling Grids for Year 22 (2016) Monitoring

2016 Grid Cell Station ID	Latitude	Longitude	Sampling Requirements		
			No. Discrete Surface Samples (0 to 10 cm) within Grid Cell for Composite (one analytical sample)	Discrete Suburface Cores (0 to 6 ft)	No. Discrete Shallow Core Samples (0 to 2 ft) for Composite (one analytical sample)
I-12					
I12-c3	47 36 58.00	122 30 15.59	-	-	3
I12-b2	47 36 58.36	122 30 16.27			
I12-e2	47 36 58.57	122 30 14.18			
Two additional stations will be identified in the field			-	-	3
			-	-	3

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Table FSP - 2. Sample Types, Sample Matrix, Number of Surface and Core Samples, and Sample Analyses

Associated Field and Analytical Actions	Sample Numbers		Conventionals (TOC, Total Solids)	Grain Size	PCP by 8041	PAHs by 8270 SIM	Mercury
	Surface Sediment	Cores Number					
Subtidal Cap							
Surface Samples within grids J9 and J10. • Two (2) composite samples • Three sub-grid stations sampled and composited for each parent grid. • Analyze for conventionals, grain size, PAHs, PCP, and mercury.	2	---	2	2	2	2	2
Exposure Barrier System and West Beach							
West Beach Exposure Barrier Surface Sediment Samples • Six (6) composite samples • Four (4) from the 2011 OMMP locations and two (2) in-field designated stations • Three sub-grid stations sampled and composited for each parent grid. • Analyze for conventionals, grain size, PAHs, and PCP.	6	---	6	6	6	6	---
North Shoal Subtidal Area							
North Shoal Sediment Cores • Five (5) coring locations at centroid in grids J7, K7, J8, K8, and L8. • Cores collected and logged to 6-ft below mud line • No chemical analyses on collected cores	---	5	---	---	---	---	---
North Shoal Subtidal Surface Sediment Samples • Five (5) composite samples at grid J7, K7, J8, K8, and L8. • Three sub-grid stations sampled and composited for each parent grid. • Analyze for conventionals, grain size, PAHs, PCP, and mercury.	5	---	5	5	5	5	5
Totals	**13**	**5**	**13**	**13**	**13**	**13**	**7**

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Table FSP - 3. Projected Field Project Schedule

Date	Activity
July 5 - 6, 2016	USACE Clam Tissue Survey
1/ 5 - 17/2017	Bathymetric Survey
1/ 6 - 20/2017	Photogrammetry Survey
1/12 - 13/2017	EBS and West Beach Sampling
1/18/2017	Mobilization for Field Work
1/19 - 20/2017	Subtidal Surface Sediment Chemistry Sampling
1/21 - 23/2017	Subtidal Subsurface Coring
1/23 - 24/2017	Core Processing

Table FSP - 4. Horizontal Control Points at and around the East Harbor Operable Unit

Station	Latitude (NAD 83 - North)	Longitude (NAD 83 - West)	Washington State Plane Coordinates NAD 83	
			X	Y
Horizontal Control Points				
DOT	47 37 17.432	122 30 50.577	1225961.95	231233.5
MARINA	47 36 58.375	122 30 46.883	1226172.81	229297.45
NAVAID	47 37 19.155	122 29 50.597	1230073.67	231318.72

Table FSP - 5. Quality Assurance Quality Control Samples

Field Groups and Associated QA/QC	Sample Numbers		Conventionals (TOC, Total Solids)	Grain Size	PAHs by 8270-SIM	PCP by 8041	Mercury
	Surface Sediment	Cores Number					
Subtidal Cap and North Shoal Subtidal Surface Sediment Samples							
Field Replicates (5%)	7	---	1	1	1	1	1
MS/MSD (5%)			1	1	1	1	1
Water - Equipment Rinsate (5%)			1	1	1	1	1
Exposure Barrier System and West Beach							
Field Replicates (5%)	---	6	1	1	1	1	---
MS/MSD (5%)			1	1	1	1	---
Water - Equipment Rinsate (5%)			1	1	1	1	---

Table FSP - 6. Sample Type, Container, Holding Times, Preservatives, and Storage Requirements

Parameter	Minimum Sample Size[1]	Container Description	Preservation Requirements	Holding Time
Sediment Samples				
Grain size	100 g	16-oz glass or HDPE	4°C ±2°C	6 months
TOC	25 g	4-oz glass	4°C ±2°C -20°C ±2°C	14 days 6 months
Total Solids	50 g		4°C ±2°C -20°C ±2°C	14 days 6 months
Mercury [2]	1 g	4-oz glass	4°C ±2°C -20°C ±2°C	28 days 1 years
PAHs and PCP	200 g	8-oz glass	4°C ±2°C -20°C ±2°C	14 days 1 year
Archive	1000 g	16-oz glass	-20°C ±2°C	6 months
Water Samples				
Mercury	10 mL	500ml HDPE	HNO3, 4°C ±2°C	28 days
PAHs and PCP	500 mL	4 x 500 mL Amber glass	4°C ±2°C	7 days

Notes:

1. Recommended minimum field sample sizes for one laboratory analysis. Actual volumes to be collected have been increased to provide a margin of error and allow for retests.

2. During transport to the lab, samples will be stored on ice. The mercury sample will either be analyzed immediately or frozen upon receipt at the laboratory. The archived samples will be frozen immediately upon receipt at the lab.

HDPE - high density polyethylene

PAHs - polycyclic aromatic hydrocarbons

PCP - pentachlorophenol

TOC - total organic carbon

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	Project Name	Figure Name	
SEE LLC Science & Engineering for the Environment / HDR	2016 OMMP Implementation East Harbor Operable Unit Wyckoff/Eagle Harbor Superfund Site	Aerial Photograph of the East Harbor Operable Unit, Wyckoff/Eagle Harbor Facility	**Figure FSP-1**

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Project Name	Figure Name	
2016 OMMP Implementation East Harbor Operable Unit Wyckoff/Eagle Harbor Superfund Site	Locations of Intertidal and Subtidal Sediment Caps and Exposure Barrier System	**Figure FSP-2**

SEE LLC Science & Engineering for the Environment

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Project Name	Figure Name	
2016 OMMP Implementation East Harbor Operable Unit Wyckoff/Eagle Harbor Superfund Site	Intertidal Area Designations	Figure FSP 3

SEE LLC Science & Engineering for the Environment

HDR

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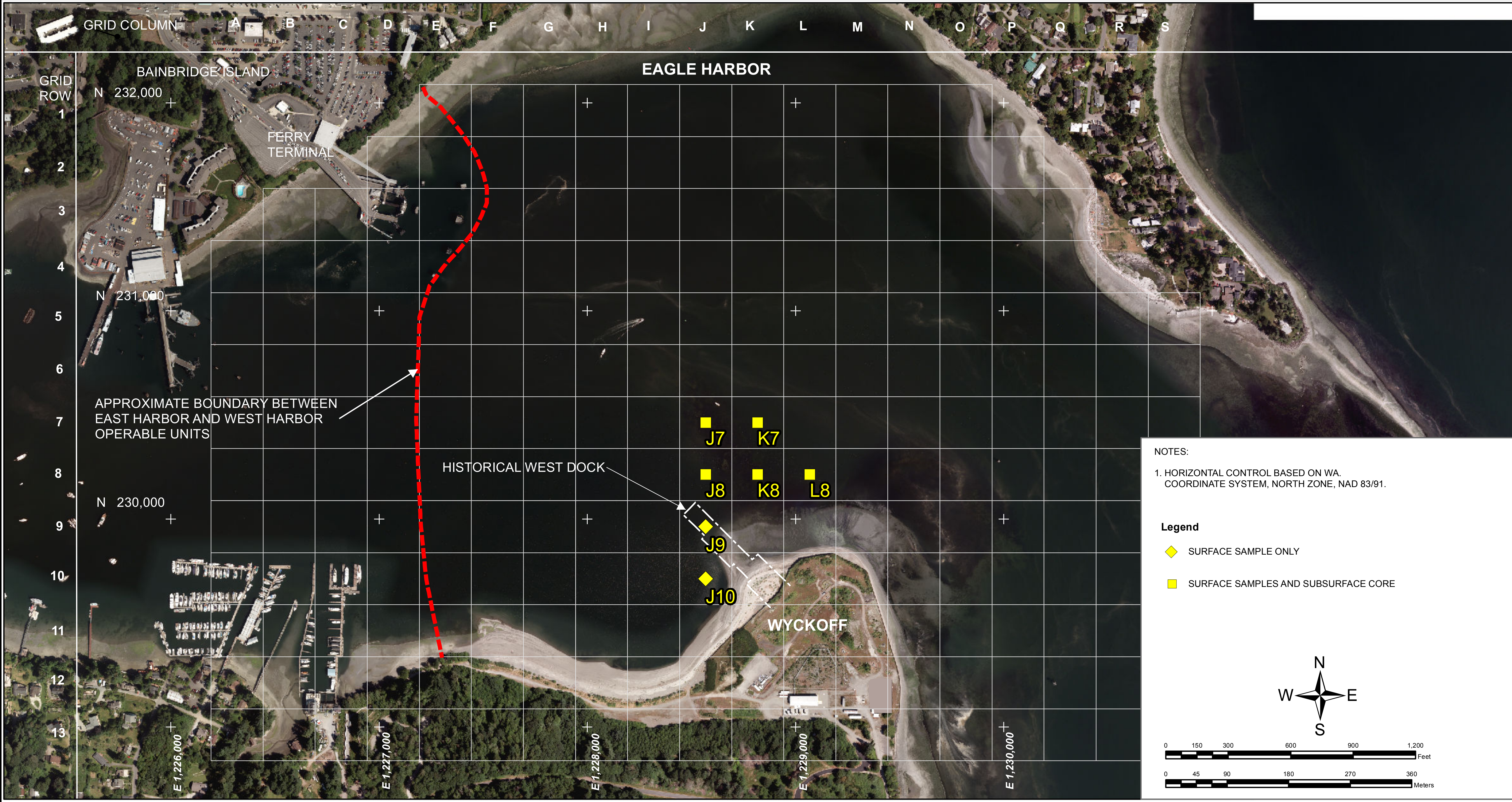

Project Name	Figure Name	
2016 OMMP Implementation East Harbor Operable Unit Wyckoff/Eagle Harbor Superfund Site	Subtidal Sampling Grid Locations	**Figure FSP-4**

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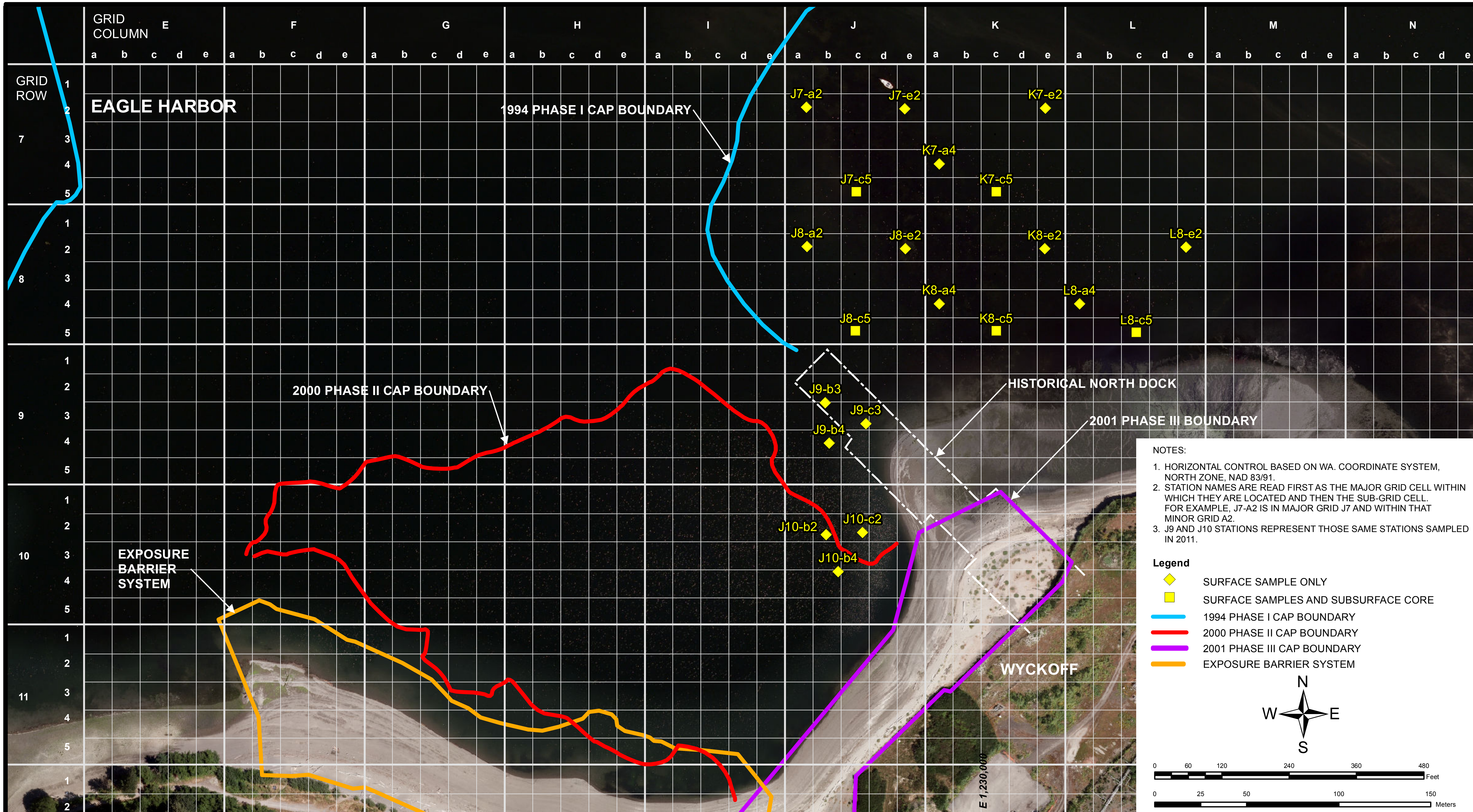

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HDR

Project Name

2016 OMMP Implementation
East Harbor Operable Unit
Wyckoff/Eagle Harbor Superfund Site

Figure Name

Subtidal Surface
Sediment Chemistry Sampling Locations

Figure FSP-5

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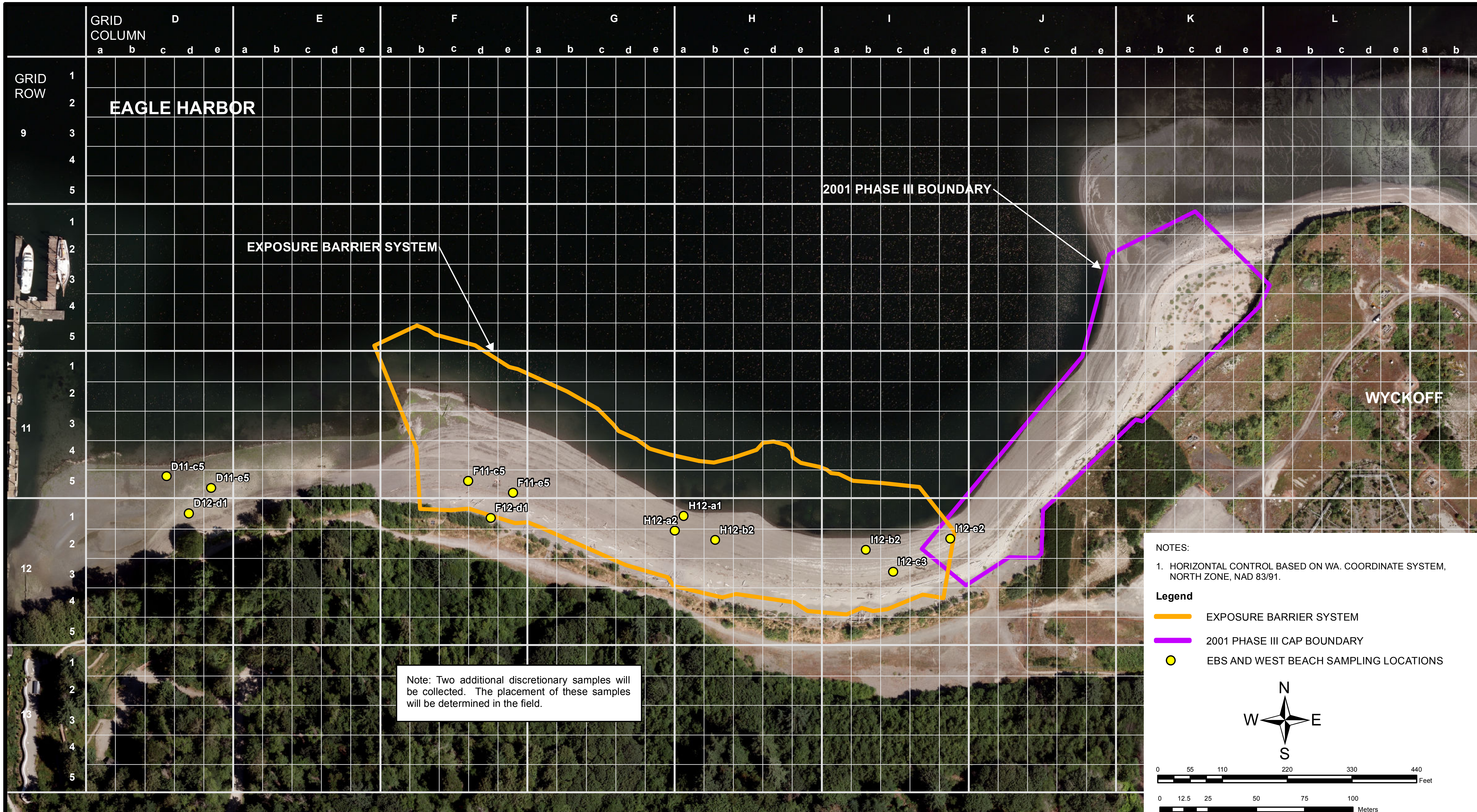

Project Name	Figure Name	
2016 OMMP Implementation East Harbor Operable Unit Wyckoff/Eagle Harbor Superfund Site	Exposure Barrier System and West Beach Sediment Sampling Locations	Figure FSP-6

SEE LLC Science & Engineering for the Environment

HDR

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CORE PROCESSING LOG

Station ID:

Project: **Eagle Harbor Monitoring**	Core Type : Vibracore	Core Size: 4" OD Aluminum; 3.75" ID
Location Description		
Time: Date:	Logged By:	Cored By: Marine Sampling Sys.
Water Depth: Water Level:	Penetration:	Acquisition:

Depth (unit)	Sampling: % Recov	Sampling: Sample Depth	Sampling: Sample #	Sampling: PID	Sampling: Munsel Color	Lithology Description Sediment Type lithification, moisture content, porosity, permeability/fracturing

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Appendix A

Final Quality Assurance Project Plan Wyckoff/Eagle Harbor Superfund Site Clam Tissue Sampling

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2016 QUALITY ASSURANCE PROJECT PLAN UPDATE

CLAM TISSUE SAMPLING

WYCKOFF/EAGLE HARBOR SUPERFUND SITE
Bainbridge Island, WASHINGTON

EPA CERCLIS SITE ID# WA009248295

Prepared for:

U.S. ENVIRONMENTAL PROTECTION AGENCY
Region 10
1200 6th Avenue
Seattle, Washington 98101

Prepared by

U.S. ARMY CORPS OF ENGINEERS
Seattle District
4735 East Marginal Way South
Seattle, Washington 98134

June 2016

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TITLE AND APPROVAL SHEET
2016 CLAM TISSUE SAMPLING
QUALITY ASSURANCE PROJECT PLAN (QAPP) UPDATE
WYCKOFF/EAGLE HARBOR SITE, BAINBRIDGE ISLAND, WASHINGTON

Robert Yust ____________________ Date 6/22/16
Robert Yust
USACE Project Manager

Jacob Williams ____________________ Date 6/22/16
Jacob Williams
USACE Project Chemist

Marlowe Laubach ____________________ Date 22 Jun 2016
Marlowe Laubach
USACE Technical Lead

Helen H. Bottcher ____________________ Date 6/22/2016
Helen Bottcher
EPA Region 10 Remedial Project Manager

____________________ Date 6/22/2016
Donald M. Brown
EPA Region 10 Quality Assurance Manager

QUALITY ASSURANCE PROJECT PLAN AMENDMENT

This Quality Assurance Project Plan (QAPP) update (to the 2014 QAPP) describes the third clam tissue sampling activities which are a part of the existing monitoring for the Wyckoff/Eagle Harbor Superfund Site remedy. The Wyckoff/Eagle Harbor Superfund site is located on the southern shoreline near the entrance to Eagle Harbor and has four operable units. This QAPP addresses clam sampling within the East Harbor Operable Unit 01 that includes intertidal and subtidal sediments of the site. The remedy for the Wyckoff/Eagle Harbor Superfund Site included: placement of a clean sediment cap over approximately 50 acres of contaminated subtidal and intertidal sediments in the East Harbor. The QAPP update is based on the *Intergovernmental Data Quality Task Force Uniform Federal Policy for Quality Assurance Project Plans Guidance (EPA 2009)*. Data from the clam tissue sampling activities will be included in the next Five Year Review.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ATTACHMENTS (refer to QAPP April 2014)

LIST OF ACRONYMS

EPA	United States Environmental Protection Agency
EIM	Environmental Information Management
GPS	Global Positioning System
HHRA	Human Health Risk Assessment
HPAH	High-molecular weight PAHs
MEL	EPA R10 Manchester Environmental Laboratory
MRL	Method Reporting Limit
PAHs	Polycyclic Aromatic Hydrocarbons
PDT	Project Delivery Team
PQOs	Project Quality Objectives
QAPP	Quality Assurance Project Plan
QC	Quality Control
ROD	Record of Decision
RSCC	Regional Sample Control Coordinator
SOP	Standard Operating Procedure
SSHP	Site Safety & Health Plan
TEQ	Toxic Equivalent Quantity
μg/kg	Microgram per kilogram
USACE	United States Army Corps of Engineers

1. PROJECT MANAGEMENT AND OBJECTIVES

1.1. Project Organization, Responsibilities and Authority

This update describes changes to the Quality Assurance Project Plan (QAPP) for clam tissue sampling that was approved and implemented in May 2011 and amended in April 2014. Changes from the previous QAPP include the timeframe when sampling is conducted and the use of Scribe software for sample management. Sample handling and analytical procedures remain the same and the reader should review the May 2011 QAPP along with Amendment 1 dated April 2014. The Project Delivery Team (PDT) for this QAPP update includes members from United States Environmental Protection Agency Region 10 (EPA), the United States Army Corps of Engineers (USACE), and the Suquamish Tribe. Funds for this project have been secured through the Comprehensive Environmental Response, Compensation and Liability Act cleanup program.

The roles of the project team members are the same as the previous QAPP.

1.1.1. EPA Region 10 Personnel Responsibilities and Qualifications (refer to QAPP April 2014)

1.1.2. USACE Personnel Responsibilities and Qualifications (refer to QAPP April 2014)

The USACE project manager has changed from Karl Kunas to Robert Yust and the technical lead has changed from Deborah Johnston to Marlowe Laubach. The USACE chemist has changed from Cathy Martin to Jacob Williams. Jacob Williams will also be the USACE Scribe Manager.

1.1.3. Special Training Requirements and Certifications (refer to QAPP April 2014)

1.2. Project Planning

1.2.1. Project Planning (Scoping)

Several meetings have been held with EPA, the Suquamish Tribe and USACE PDT members. Topics discussed include:

- Project Schedule
- Data Collection for the Next Five Year Review

The outcomes of the meetings are documented by incorporation into this updated QAPP.

1.2.2. Problem Definition, Site History, and Background (refer to April 2014 QAPP for additional details)

The Wyckoff/Eagle Harbor Superfund site is located on the east side of Bainbridge Island, in Central Puget Sound, Washington. The East Harbor Operable Unit 01 consists of more than 70 acres of intertidal and subtidal habitats that were contaminated by releases of creosote and other wood-treating chemicals from a now defunct wood treating plant. The releases contaminated the bottom sediments of Eagle Harbor, primarily with polycyclic aromatic hydrocarbons (PAHs).

Eagle Harbor is within the usual and accustomed fishing area of the Suquamish Tribe.

The work for this updated QAPP supports the following:

1. Obtain clam tissue sampling data for contaminants of concern described in the Record of Decision (ROD).
2. Determine if clam tissue contamination levels have changed due to natural recovery.
3. Collect site-specific background clam tissue data.

Clam tissue PAH concentrations will be used in the next Five-Year Review and to update sampling locations and procedures as appropriate. The work is expected to be completed during the low tides in July 2016. Collection and analysis will assist EPA to assess the natural recovery process. The ROD states that monitoring is necessary to document natural recovery.

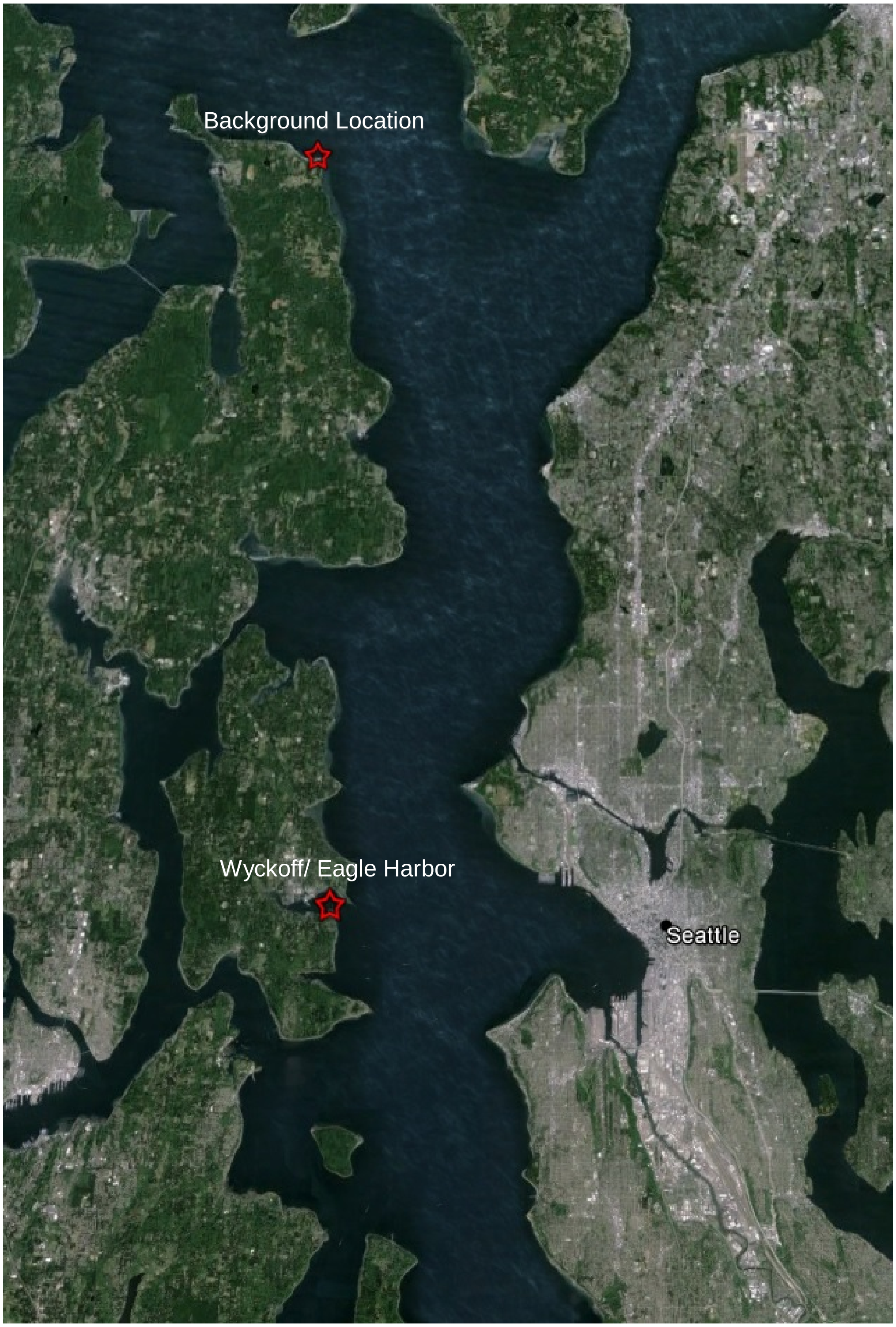

Figure 1. Sampling Location Vicinity Map

Figure 2. Wyckoff/Eagle Harbor Vicinity Map

Figure 3. Wyckoff Sampling Locations

Figure 4. Background Location

1.2.2.1 Remedy and Status (refer to QAPP April 2014 for additional information)

This monitoring event is designed to provide additional data on clam tissue PAH concentrations over time. Clams will be collected from all beach locations and analyzed for PAH concentrations and lipid content. The data may be of sufficient quality to determine if concentrations have changed when compared to the previous clam tissue data and provide data sufficient to support future human health risk assessment (HHRA).

Native horse clams (*Tresus capax*) will be collected from approximately the same locations as during the previous two monitoring event in Eagle Harbor. In addition, native horse clams (*T. capax)* will be collected from a background location in Puget Sound. Clams will be collected and analyzed for PAH tissue concentrations and percent lipid content. A minimum of 100 grams of clam tissue (whole body without shell) is required for each composite for analysis of PAH and lipids. Based on the clam weights from the 2014 monitoring event in Eagle Harbor it is approximated that three clams of legal size (5 inches and having 78 grams of shucked tissue each) will provide the 20 grams of tissue needed for the PAH analysis (10 grams) and lipid determination (10 grams) from each sample location. Samples designated for duplicates, matrix spike and matrix spike duplicates will need at least 40 grams of homogenized material.

1.3. Project Quality Objectives and Measurement Performance Criteria

1.3.1. Development of Project Quality Objectives Using the Systematic Planning Process

Project Quality Objectives (PQOs) are developed through the systematic planning process as described in the UFP-QAPP Guidance. They are used for determining the type, quantity, and quality of data as described in Table 1.

Table 1. Project Quality Objectives

Project Quality Objectives - Wyckoff /Eagle Harbor Clam Tissue Sampling			
Problem Statement	Investigation Method	Performance Criteria	Data Use
1. How is the Natural Recovery remedy affecting PAH tissue concentrations in horse clams?	Collect horse clams from the 4 beach segments in July 2016: West Beach, Intertidal Cap, North Shoal, East Beach. Those sample concentrations will be compared to the tissue concentrations from the previous sampling events. A background location will be added for	Analyze harvestable size horse clam tissue for PAHs and lipid content. PAH laboratory reporting limits will be at the 1 µg/kg MRL or better.	Are tissue concentrations declining over time? If yes, this will indicate that monitored natural recovery is still occurring. 2016 sampling results will provide current data against which post-remediation data can be compared.

Project Quality Objectives - Wyckoff /Eagle Harbor Clam Tissue Sampling			
Problem Statement	Investigation Method	Performance Criteria	Data Use
	comparison to tissue concentrations from the 4 beach segments.		
2. Are the tissue PAH concentrations at West Beach different from concentrations at the other 3 segments?	Compare tissue PAH concentration from West Beach clams to each of the other segments PAH tissue concentrations.	Analyze edible horse clam tissue for PAHs and lipid content. PAH laboratory reporting limits will be at the 1 µg/kg limit or better.	Do clams that have settled at West Beach (a clean habitat) have PAH concentrations lower than clams from the other beaches? If yes, this will indicate that a sediment removal remediation (to reduce the concentration of PAHs in sediments) may be considered as another remedy to natural recovery.
3. Is there sufficient data to calculate a HHRA for subsistence users eating horse clams?	Determine the appropriate parameters for use in a HHRA regarding consumption rates. Analyze horse clam tissue for HPAHs and lipids.	Reporting limits are above the ideal method reporting limits for calculating the TEQ[1]. However, this is acceptable for the project to look at contaminant concentration trends.	Calculate PAH concentrations (TEQ) in clam tissues and use the results to calculate the risk of shellfish consumption at recreational and Tribal consumption levels.
4. How does the tissue PAH concentrations at the 4 beach locations compare to background areas in Puget Sound?	Collect samples in a suitable background location to build the background data set. Compare tissue PAH concentrations to background.	Analzye edible horse clam tissue for PAHs and lipid content. PAH laboratory reporting limits will be at the 1 µg/kg limit or better.	Perform a statistical comparison between the background areas and site.

[1] The TEQ will be calculated for carcinogenic PAHs using the potency factors from the 1993 EPA Provisional Guidance for Quantative Risk Assessment of PAHs. Detections between the method reporting limit/limit of quantitation and the limit of detection should be qualified with a “J”.

Table 2. Project Data Needs (Remedy Perspective)

Data Need		Data Use		Number or Frequency of Primary Samples	Concentration of Interest; Sensitivity of Measurement	Remediation Area(s)/Sample Location(s)
Target Analyte or Characteristic of Interest	Matrix	Remedy Method of Interest	Criteria to be Considered			
Remedy Perspective						
PAHs	Tissue	Sediment Cover	Conceptual Site Model	12	1 µg/kg (wet weight)	Wyckoff/Eagle Harbor intertidal areas
Lipid	Tissue			12	Top-loading balance: ±2% or ±0.02g, whichever is greater	
PAHs	Tissue	Background	Conceptual Site Model	3	1 µg/kg (wet weight)	background location
Lipid	Tissue			3	Top-loading balance: ±2% or ±0.02g, whichever is greater	

1.3.2. Measurement Performance Criteria (refer to QAPP April 2014)

1.4. Secondary Data Evaluation (refer to QAPP April 2014)

1.5. Project Overview and Schedule

Through project planning, the project team has agreed on the purpose of the project, the environmental questions that are being asked, and the environmental decisions that must be made. PQOs have been developed specifying the type, quantity, and quality of data needed to ensure that project data can be used for the intended purpose to answer specific environmental questions, support environmental decisions, and determine technical activities that will be conducted. Table 3 provides a summary of the project tasks to be completed and Table 4 describes the project schedule.

Table 3. Project Tasks

Plan, Prepare QAPP
• Prepare an updated QAPP and a site-specific Site Safety Health Plan (SSHP) to govern the sampling • Prepare, finalize, and approve updated QAPP
Sampling Tasks
• Sample clams at 15 intertidal sample locations
Analytical Tasks
• Analyze all clam tissue PAH samples by Quechers extraction and EPA Method 8270D with GC-MS-MS • Analyze lipids gravimetrically by EPA Method 3541C ($MeCl_2$ extraction) per MEL SOP
Quality Control Tasks
• Tissue (PAH and lipids) samples will have 1 duplicate for each beach location and one MS/MSD sample. • Analytical methods QC will comply with laboratory SOPs.
Secondary Data
• No secondary data will be collected.
Data Management Tasks
• EPA Scribe software will be used for data management as per R10 Data Management Plan • Validated/verified analytical data and sample coordinates will be placed in the EQuIS™ database. Data from the Scribe format will be available for input into the EIM database.
Documentation and Records
• Follow EPA R10 Data Management Plan for collection of field data including use of Scribe • All generalized sample locations will be recorded in field notebook. • Field notebook will contain the following: date and time of sample collection, weather conditions, sample identification number, type of sample, general location of sampling points (GPS), depth of clams below the beach surface, and any procedural steps taken that deviate from those outlined in this updated QAPP. • Prepare a Final Monitoring Report that describes the field effort, sampling results and data quality, decisions made, and recommendations for future actions.
Data Packages
• 100% of data packages will be validated through Stage 4 (S4VM) by EPA MEL. All data packages will be delivered to USACE and maintained at MEL at the Stage 4 level.
Assessments and Audits
• Sampling SOPs have been reviewed. • Field sampling records will undergo review after the samples are collected. • Laboratory sample receipt reports will be reviewed after samples are received. • Scribe files and deliverables will be verified by the EPA RSCC and MEL upon receipt (R10 Data Management Plan 4/2014).

Data Review Tasks
• The laboratory performing analyses of samples will verify that all data are complete for samples received. • Data will be validated undergo a full data quality review in accordance with the EPA MEL review policies and SOPs. • Validated data will be reviewed by USACE. • Data usability will be assessed by USACE. • Measurement performance criteria set in QAPP checked by USACE. • Data limitations will be determined. Data compared to PQOs by USACE.

Table 4. Estimated Project Schedule

Task #:Description	Start	Finish
Task #1: Plan, Prepare QAPP		
Prepare amended QAPP and SSHP	3/28/2016	4/15/2016
Submit amended QAPP for comments and receive comments	5/17/2016	6/7/2016
Final amended QAPP approval	6/22/2016	6/24/2016
Task #2: Field Work (Collect Clams, Transport to MEL)		
Collect clams and submit to EPA Manchester lab	7/05/2016	7/06/2016
Task #3: Review Lab Data and Prepare Monitoring Work		
Analysis turnaround anticipated	7/06/2016	7/27/2016
Review lab data and prepare data quality reports	7/27/2016	8/10/2016
Prepare draft monitoring report	7/27/2016	8/26/2016
USACE internal review comments due	8/26/2016	9/2/2016
Prepare draft final monitoring report	9/6/2016	9/16/2016
EPA/Tribe/State review	9/19/2016	10/3/2016
Prepare Final Monitoring Report	10/4/2016	10/14/2016

2. MEASUREMENT AND DATA ACQUISITION

2.1. Sampling Tasks

2.1.1. Sampling Process Design and Rationale (refer to QAPP April 2014)

2.1.2. Sampling Procedures and Requirements (refer to QAPP April 2014)

2.2 Analytical Tasks (refer to QAPP April 2014)

2.3 Sample Collection Documentation, Handling, Tracking and Custody Procedures (refer to QAPP April 2014)

2.4 Quality Control Samples (refer to QAPP April 2014)

Sufficient sample mass shall be collected to include the following QC samples.

Laboratory QC Sample Requirements					
Analytical Parameter	**# Sample Duplicates (grams)**	**% Sample Duplicates (min. approx 10%)**	**MS/MSDs**	**%MS/MSD (min. 5%)**	**Laboratory Triplicate RSD**
PAHs	1 (10g)	8.3%	1 (20g)	8.3%	NA
% Lipids	1 (10g)	8.3%	NA	8.3%	1 sample (30g)

2.5 Data Management Tasks (refer to QAPP April 2014)

2.5.1 Project Documentation and Records (refer to QAPP April 2014)

2.5.1.1 Amended QAPP and Site Safety and Health Plan

Hardcopies of the updated QAPP and SSHP will be stored in project files.

2.5.2 Data Package Deliverables (refer to QAPP April 2014)

2.5.3 Electronic Data Reporting Formats (refer to QAPP April 2014)

2.5.4 Data Handling and Management (refer to QAPP April 2014)

2.5.5 Data Tracking and Control (refer to QAPP April 2014)

3. ASSESSMENT AND OVERSIGHT (refer to QAPP April 2014)

4. OVERVIEW (refer to QAPP April 2014)

5. REFERENCES

U.S. Environmental Protection Agency. 2009. *Intergovernmental Data Quality Task Force Uniform Federal Policy for Quality Assurance Project Plans Guidance*

Appendix B

Scope of Work Bathymetric Survey Wyckoff/Eagle Harbor Superfund Site Bainbridge Island, Washington

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SCOPE OF WORK
TOPOGRAPHIC SURVEY
WYCKOFF/EAGLE HARBOR EAST HARBOR OU
OMMP IMPLEMENTATION
BAINBRIDGE ISLAND, WASHINGTON

20 December 2016

1.0 INTRODUCTION

This scope of work (SOW) details the specific tasks required for topographic mapping in support of the Wyckoff/Eagle Harbor Superfund Site East Harbor Operable Unit (EHOU) Operations, Maintenance and Monitoring Plan (OMMP). The mapping will be used to provide an indication of cap thickness, and support determination of sampling locations. The general objectives of this SOW include but are not limited to:

- Conduct field surveys to establish control and make check point measurements
- Acquire and process aerial imagery
- Acquire and process airborne lidar data
- Acquire and process bathymetric survey data
- Combine elevation data into fused data set
- Reporting

1.1 Objectives

The objective for this work are to perform a topographic survey of the study area, and provide digital elevations and orthophoto imagery of the survey data.

1.2 Authority

The monitoring and other activities described herein are being conducted pursuant IA DW-96-957580 between USACE and EPA Region 10.

2.0 SURVEY TEAM

The topographic survey team will be led by Miller Creek Aerial Mapping (MCA). MCA will be responsible for project management, photogrammetry, deliverable preparation and reporting for the topographic survey portion of the project. Following are the supporting firms and their roles on the project.

- APS Surveying & Mapping – Field surveys
- Terrasond – Bathymetric surveys
- GeoTerra – Airborne lidar acquisition
- GPS Surveying – Aerial imagery acquisition

3.0 DESCRIPTION OF WORK

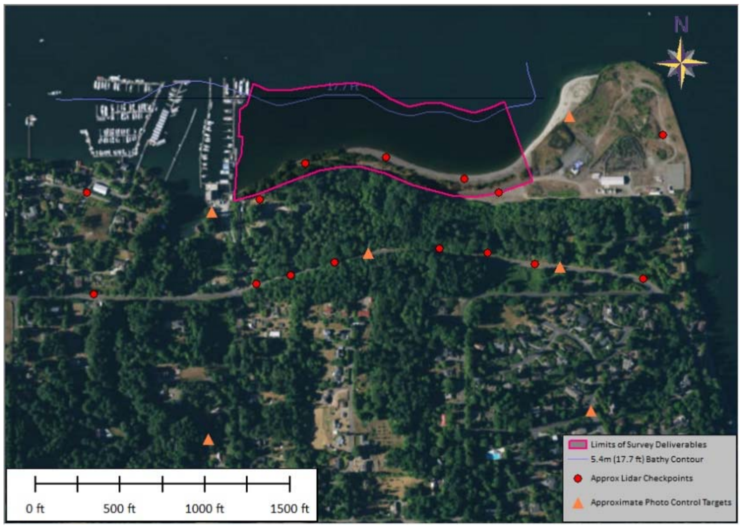

Figure 1- Mapping limits, photogrammetric control and lidar check points

The topographic surveys will be conducted using a combination of airborne lidar data acquired during a period of low tide, and a bathymetric survey conducted during a high tide period. In addition, digital orthoimagery will be prepared to show current site conditions. The mapping limits and control locations are shown on Figure 2.

The lidar data will be acquired at an altitude of 1,500 m or lower using a 50% lateral overlap approach to achieve a minimum density of 8 points per square meter. These parameters have been shown to result in point data with a vertical RMSE of ≤10 cm.

Multi-spectral aerial imagery will be acquired using a gyroscopically stabilized Vexcel UltraCam Falcon precision digital imaging sensor at a nominal resolution of 0.15-ft. The stereo imagery and project elevation data will be utilized to prepare natural color orthoimagery with a ground sample distance of 0.2-ft.

The bathymetric data collection will be completed using TerraSond's vessel Ospika. The crew will consist of one vessel captain and one surveyor. The survey area will be from the +4 ft. MLLW contour at the inshore limit to the project area extents.

Multibeam data will provide accurate depth information in the survey area. All standard survey quality control checks will be performed. Multibeam data acquisition will consist of 100% coverage below the 4 ft elevation within the highlighted survey area in Figure 1. The survey vessel is a shallow draft jet boat that will be trailered to Bainbridge and launched near the project area. The survey will be planned during a high tide to enable survey in the shallowest possible waters.

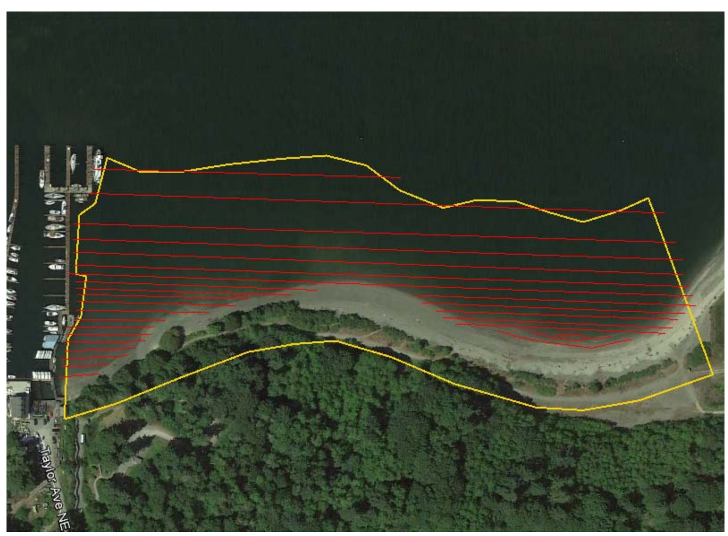

Figure 2- Project limits with approximate line plan based on sonar coverage and depth.

QPS QINSy data acquisition software will be used for data collection. The software generates a real-time, corrected coverage map and survey line spacing is adjusted on the fly. Line spacing is variable depending on the depths, and more or less runs parallel with the contours. Generally, the survey lines will be run with spacing such that overlap between adjacent lines is achieved at a 45-degree swath angle.

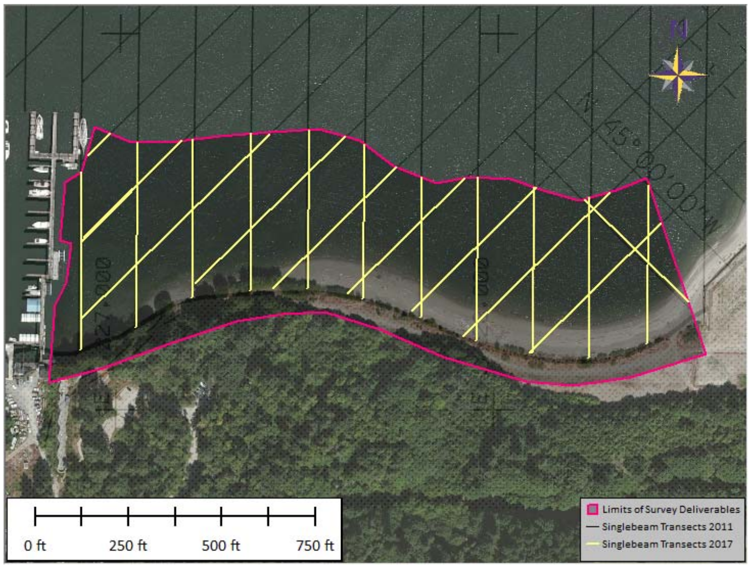

Figure 3- Project limits with approximate singlebeam line plan based on previous survey.

In addition to the multibeam survey, a singlebeam survey will be performed. This data will be acquired using the same Terrasond survey crew and vessel. Singlebeam data acquisition will consist of grid, run at a spacing matching those of previous years as indicated in Figure 3. The survey extents will be limited to the outlined area indicated in Figure 3.

The survey crews will provide their own requisite materials, equipment, personnel and computations to accomplish a Special Order hydrographic survey of specified work.

3.1 Standards

Hydrographic Survey
The survey will conform to the EM 1110-2-1003 "Hydrographic Surveying Manual" accuracy standards for Class 3 surveys, procedure specifications for bathymetry and specifications contained herein.

Prior to and during data collection, a series of quality assurance checks will be conducted to verify the sounding accuracies. The results of the quality control checks will be included in the final survey report.

The checks conducted include:

1. Control Check

   The survey will be controlled horizontally and vertically by Real Time Kinematic (RTK) GPS using corrections from a dedicated RTK GPS base station set at a primary control station. Prior to the beginning of the survey, control checks will be conducted to verify the control. The RTK base station will be set up on an existing monument and a check shot will be completed on a second existing monument. The result of the check shot will be compared against the record value for the monument verifying the RTK setup.

2. Positioning System Check

This check is performed to verify the accuracy of the vessel positioning system. This is typically checked by verifying the vessel positioning system with an independent positioning system. A comparison between the vessel position from the F180 IMU and an independent Trimble R8, both in RTK mode, receiving corrections from the same base will be completed.

3. Water Surface Check

   RTK GPS will be used to monitor the water level during survey and correct the soundings to the project datum. The RTK accuracy will be checked by recording RTK water surface elevations on the vessel while simultaneously measuring the water surface elevation using RTK GPS from the known control.

4. Bar Check

   A bar check will be conducted to accurately verify sonar soundings and the vertical offsets applied in post processing. A bar will be lowered below the sonar and raw files will be recorded at that depth. The raw files will be processed using the standard processing flow in CARIS HIPS. This accounts for all vertical offsets for the positioning and multibeam locations, sonar draft and sound velocity. The processed soundings compared to the bar depth will be included in the final report.

5. Patch Test

   A patch test is a set of systematic lines that are run to determine the alignment errors between the motion reference unit and the multibeam. A patch test will be conducted on site before the start of the survey.

6. Crossline Analysis

   A line will be run perpendicular to the main scheme lines will be completed. A base surface of the main scheme lines will be generated and the QC Report function in CARIS HIPs will be utilized for the crossline analysis. The beams of the crossline will be analyzed against the surface to determine if the data was meeting IHO Special Order for navigation surveys as specified in EM1110-2-1003.

The hydrographic survey vessel conforms to the U.S. Coast Guard requirements for passenger carrying vessels of its size. The vessel has adequate seating space for each survey crewmember. The entire survey crew must have Government ID in his/her possession while onboard the hydrographic survey vessel.

Upland Survey

The upland topographic survey will be produced to meet the ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014) for a 20 cm $RMSE_x$ / $RMSE_y$ Horizontal Accuracy Class, and a 10 cm $RMSE_z$ Vertical Accuracy Class. The orthoimagery will be produced to meet the ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014) for a 6 cm $RMSE_x$ / $RMSE_y$ Horizontal Accuracy Class.

3.2 Datum

Final horizontal positions will be referenced to the Washington Coordinate System, North Zone, NAD 83/91.

Final vertical positions will be referenced to both the North American Vertical Datum (NAVD) 88 (Geiod 03) and NOS Mean Lower Low Water (MLLW), Tidal Epoch 1983-2001.

The unit of measurement will be the U.S. Survey Foot.

3.3 Depth Measurement

Echo Sounding for depth will be accomplished by a fully integrated and automated hydrographic data acquisition system utilizing multibeam technology that:

a) Is capable of speed of sound correction adjustments and has a frequency operating capability of 400 kHz.

b) Has motion sensor capability with a manufacturer's stated compensation accuracy of +/- 0.025degrees or less for vessel pitch and roll and the greater of 5 cm or 5% for heave. Positioning during RTK operations is 0.02.

Sound velocity profiles will be completed at the beginning and end of the survey as well at an interval of no more than 2 hours during the survey.

3.4 Data Processing

The data will be processed using CARIS Hips and Sips software. CARIS uses a standard workflow to merge the GPS data, motion data, depth and sound velocity into the final soundings. Sounding files will be edited to eliminate extraneous data and display an accurate representation of the harbor. A final 1 foot grid of the surface will be utilized to generate the contract deliverables.

The airborne lidar data will be adjusted to field surveyed points, and processed to standard LAS v1.2 format. The data will be auto-classified into ground, water and non-ground classes. The ground class will be edited, and fused with the hydrographic data to form a single ground/bathymetric elevation model. The elevation model will also be used to rectify the airborne imagery.

3.5 Deliverables

Following is a list of the deliverables for the topographic mapping portion of the OMMP project.

- An x, y, z coordinate data file will be provided for the hydrographic survey in comma-delineated ASCII format. Data sequence will be Point ID, Northing, Easting, Elevation, and Description. All horizontal and vertical control monuments utilized, their location, designation, description, and XYZ values will be clearly defined.
- All lidar points will be delivered in LAS v1.2 format.
- All ground lidar and bathymetric points will be delivered in LAS v1.2 format.
- All ground lidar and bathymetric points will be delivered in comma delimited ASCII format.
- Color digital orthoimagery will be delivered in TIFF format with .TFW georeferencing files.
- A color digital orthoimagery mosaic will be delivered in MrSid format.

3.6 Schedule

Based on approval of the project work plan by January 6, 2017, we anticipate commencing field surveys on January 9. Field survey activity should be completed within two days, opening the window of opportunity for the aerial imagery flight.

The aerial imagery flight is the most weather sensitive phase of the topographic mapping project. The imagery will be acquired as soon after photo control targeting as weather permits. Because of the time of year, the maximum sun angle will be approximately 20°, resulting in very long shadows. To improve image quality by muting the effect of shadows, our preference will be to acquire the imagery under overcast conditions.

Our primary tide window for the aerial lidar acquisition is from January 10 – 13. During this period, lower low tide levels will be -2.29-ft or lower. We will target acquisition when the tide level is below -2.0 ft. The aerial lidar flights will be conducted at night to take advantage of the low tides. If weather does not permit acquisition during this time, we will attempt the mission during the secondary period of January 27 – 28 when lower low tide levels are below -1.1-ft.

Our primary tide window for the hydrographic survey work is from January 9 – 13. During this period, high tide levels are all above 11.0-ft, and are during daylight hours. If weather does not permit acquisition during this time, there are similar suitable tide levels the following week.

4.0 COORDINATION

Points of contacts are for the work are:

- Miller Creek Aerial Mapping – Jeff Kenner, (206) 512-0301
- APS Surveying & Mapping – Tyler Sweet, (206) 746-3200
- Terrasond – Katie Mildon, (206) 420-8304

6.0 HEALTH & SAFETY PLAN

EM385-1-1 will be followed for all work. Employees will not be coming into contact with contaminants at the Wyckoff/Eagle Harbor Superfund Site.

Final 2016 Quality Assurance Project Plan

Analytical Quality Assurance Plan

East Harbor Operable Unit

Wyckoff/Eagle Harbor Superfund Site

January 9, 2017

Prepared for:

US Environmental Protection Agency
Region 10
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Seattle, WA 98101

US Army Corps of Engineers
Seattle District
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1.0 Introduction

This Analytical Quality Assurance Plan (AQAP) defines the laboratory analytical quality assurance and quality control (QA/QC) procedures to be followed for the 2016 Year 22 monitoring implementing the 2016 Operations, Maintenance, and Monitoring Plan (OMMP) Addendum (USACE and EPA 2016) for the Wyckoff/Eagle Harbor Superfund Site, East Harbor Operable Unit (EHOU) located on Bainbridge Island, Washington. Along with the Project Management Plan (PMP) and the Field Sampling Plan (FSP), these documents comprise the overall Quality Assurance Project Plan (QAPP) for Year 22 monitoring.

The AQAP provides the analytical procedures to be followed to ensure that the environmental data are of known and documented quality and suitable for their intended uses, and the environmental data collection and technology programs meet stated requirements. It includes field procedures, including instrumentation, the data quality objectives of sample collection, and numbers and types of stations to be sampled for each data type. The chemical analysis component includes detailed direction to the analytical laboratory on analytical methods, data quality objectives, sample custody, QA/QC procedures, data deliverables, data management, and reporting. The overall QAPP is provided to field staff, the analytical laboratory, and the data management team.

1.1 Purpose and Scope

The AQAP documents the appropriate analytical methods and QA procedures for the analysis of sediment and water (as equipment rinsates). The goal of the AQAP is to ensure that data of sufficiently high quality are generated to support the project Data Quality Objectives (DQOs). The DQOs for the Year 22 monitoring at the EHOU are provided in Table PMP-4, and are the Area and Monitoring Objectives listed in that table. Additional DQOs, as they relate to the procedures associated with laboratory analysis, sample custody, internal and continuing instrument/equipment calibration, internal QC checks, performance and system audits, preventative maintenance and scheduling, data quality assessment, corrective action, and QA reports applicable to this project, are described herein.

1.2 Guiding Documents

The analytical methods detailed within this document are generally consistent with those used in the 2011 Year 17 monitoring event. In order to meet the monitoring objectives it is necessary to ensure consistency in data quality between this and previous monitoring events. The AQAP specifies the procedures, policies, and QA/QC activities designated to achieve the project DQOs. To be consistent with the 2011 QAPP, this 2016 QAPP follows the *EPA Guidance for Quality Assurance Project Plans EPA QA/G5* (herein referred to as “G5”) (EPA 2002). To be consistent with past EHOU QAPPs, this document follows the general outline in the 2002 QAPP (SEA 2002).

2.0 Project Organization and Responsibilities

This section identifies individuals responsible for specific aspects of analytical work, laboratory oversight, and data validation for Year 22 monitoring. The overall project management is defined in PMP Section 1.2, with contact information provided in Table PMP-1. Personnel responsible for field sampling and laboratory analysis, quality assurance, data management, and reporting of the physical and chemical monitoring are presented in Table AQAP-1, and discussed below.

2.1 Monitoring Personnel

HDR Engineering, Inc. (HDR), and its team will conduct the field activities and sample collection specified within this FSP. Mr. Jeffery Fellows is the HDR project manager and will be the contractual point of contact for the U.S. Army Corps of Engineers (USACE) and U.S. Environmental Protection Agency (EPA), Region 10.

Mr. Tim Thompson of Science and Engineering for the Environment, LLC (SEE), is the sediment technical lead. Mr. Thompson and. David Browning of SEE will coordinate and conduct all physical and chemical monitoring tasks, as well as analysis and reporting. SEE is the technical point of contact for the USACE and EPA.

Analytical Resources, Inc. (ARI), will conduct all chemical and conventional analyses for sediments and rinsates. Archived samples, as applicable to the scope of work (SOW), will be stored at ARI until the conclusion of the period of performance for the Year 22 monitoring, at which time the samples will be transferred to the USACE or disposed at the direction of the USACE. Ms. Cheronne Oreiro of ARI is the laboratory project manager.

EPA Manchester Lab will conduct the chemical and lipid analyses according to the *Final Quality Assurance Project Plan Wyckoff/Eagle Harbor Superfund Site Clam Tissue Sampling* which was prepared by the USACE and is given in Appendix A of the FSP. The EPA lab will report through the EPA RPM to the USACE technical lead; the USACE is responsible for all QA/QC, data validation, data management, and reporting issues related to clam-tissue sampling. Mr. Gerald Dodo is the EPA laboratory project manager.

Mr. Lynn Lutz of HDR is the data QA officer, and provides QA/QC oversight of laboratory and final data validation.

3.0 Objectives for Measurement Data

There are both qualitative and quantitative criteria against which the performances of the EHOU remedies are evaluated. These are presented as the Area and Monitoring Objectives in the 2016 OMMP Addendum, and are shown in Tables PMP-4 and PMP-5 in the PMP. The types of and numbers of analytical samples necessary to meet the objectives of Year 22 monitoring are listed in Table AQAP-2. These are further detailed in Section 1 of the 2016 OMMP Addendum.

For the 2016 monitoring program, sediment samples will be collected from the exposure barrier system (EBS) and the North Shoal subtidal area only. As described in the 2016 OMMP Addendum, samples will not be collected from the Phase I, II, or III caps, the intertidal North Shoal, or the East Beach area.

Quantitative limits for the chemicals of concern have been set to evaluate the performance of the on the subtidal and intertidal caps, and the EBS. The Record of Decision (ROD) performance criteria are given in Table AQAP-3. The Washington State Sediment Management Standards (SMS), shown in Table AQAP-4, will also be used to evaluate the measured chemicals in grids J9 and J10, and the additional North Shoal subtidal stations at grids J7, J8, K7, K8, and L8

Project target analytes, quantitative limits, goals, analytical methodologies, analytical precision and accuracy criteria, and required QA/QC measurements are presented in Sections 4.0 and 5.0.

Data quality will be assessed in terms of specific data quality indicators - precision, accuracy, representativeness, comparability, completeness, and sensitivity. Definitions of these terms and applicable assessment procedures are described in Section 8.0.

3.1 Chemicals of Concern

The Chemicals of Concern (COCs) defined by the ROD include the following (Table AQAP-3):

- Polycyclic aromatic hydrocarbons (PAHs)
- Pentachlorophenol (PCP)
- Mercury

Other physical parameters that will be measured include total organic carbon (TOC), total solids, and grain size. Specific analyses by stations are listed in Table AQAP-2.

3.2 Data Quality

The quality control program associated with this investigation and documented in this AQAP has been developed to address project DQOs, and ensure the measurements on field data and laboratory analytical data are conducted in a consistent and quality manner. A more detailed description of the sampling rationale and station locations can be found in the 2016 OMMP Addendum (USACE and EPA 2016). Field sampling and measurement procedures are detailed in Section 5 of the FSP.

3.2.1 Field Measurement Data

Field measurements will include the following:

- Differential global positioning system (DGPS) station locating

- Station depth to mudline
- Sediment core boring logs

Procedures for verification of field measures are discussed in Section 5.0.

3.2.2 Geotechnical Data

Geotechnical parameters will be collected as part of the investigation. These parameters include the following:

- Grain size distribution
- Unified Soil Classification System (USCS) classification
- Moisture content
- Total solids
- Organic content

These data will not be validated, but will be verified to ensure that proper QC procedures are followed and are within method-specified control limits.

3.2.3 Laboratory Analytical Data

There are three specific media that will be analyzed in the Year 22 monitoring: sediment, water (from equipment rinsates), and clam tissue. Clam tissue QA/QC procedures are in a separate document, the *Final Quality Assurance Project Plan Wyckoff/Eagle Harbor Superfund Site Clam Tissue Sampling* which was prepared by the USACE and is given in Appendix A of the FSP. QA/QC procedures, requirements, and evaluation criteria set forth in this AQAP are subject to sediment and water samples.

The specific quantitative criteria that are applied to the sediment chemistry results are those that are defined in the 1994 ROD, and the subsequent 2007 Explanation of Significant Difference (ESD) (EPA 1994 and 2007). Those specific criteria are given in Table AQAP-3. In addition, the results from Grids J7, J8, J9, J10, K7, K8, and L8, are compared to the Washington State SMS (Table AQAP-4). A DQO for the analytical data is that the data must be of sufficient quality to be compared to these criteria. In order to make these comparisons, the laboratory reporting limits must be below those criteria. To generate data of sufficient quality for these uses, the following approach will be followed:

- Analytical methods used for sediment sample analyses will be consistent with those specified in EPA Test Methods for Evaluating Solid Waste (SW-846) (EPA 1998 and updates), the Washington State Department of Ecology's (Ecology) *Sediment Sampling and Analysis Plan Appendix* (Ecology 2008), and those specified in this AQAP.
- The laboratory data reduction and reporting will conform to the Department of Defense (DoD) Quality System Manual for Environmental Laboratories ([QSM]; DoD 2013). Data reports submitted by the analytical laboratory will be sufficient for the level of data validation defined in Section 10.
- Data quality review and validation will be performed on the analytical data according to the procedures specified in Section 10.

Documents will be retained in the laboratory for a minimum of 10 years from the time of report receipt of the report from the laboratory.

3.3 Analytical Methods

Laboratory analytical methodologies are selected for this site investigation based on the following criteria:

- The analytical laboratory will analyze samples according to EPA and Ecology approved methods.
- The chosen methods will be capable of achieving the project DQOs.

The specific analytical methods for each of the analytical parameters are presented in Section 4.0.

The laboratory's (i.e., ARI's) standard operating procedures (SOPs) and Laboratory Quality Assurance Manual must be in compliance with DoD QSM (DoD 2013) and SW846 - EPA Test Methods for Evaluating Solid Waste (EPA 1998 and updates). ARI's Quality Assurance Manuals will be maintained at the laboratories and ready for examination as needed by this project. ARI's Laboratory Quality Assurance Plan is available on the internet at http://www.arilabs.com/portal/downloads/lqap.pdf .

Table AQAP-5 summarizes sample preparation and analysis methods for sediment and water (rinsate) samples. Quality control limits for PAHs in sediments are given in Table AQAP-6, for SMS chemicals of concern in Table AQAP-7, and for water (rinsate) in Table AQAP-8 and AQAP-9.

3.4 Limits of Detection and Limits of Quantitation

Laboratory Limits of Detection (LODs) and Limits of Quantitation (LOQs)[1] for sediments are listed in Table AQAP-3 and Table AQAP-4. The LODs and LOQs are set to provide data that will be below the most stringent of either the Remedial Goals for the intertidal and subtidal area, and the SMS. Quality control limits for sediments are presented in Tables AQAP-6 and AQAP-7; those limits are further discussed in Section 4. LODs, LOQs, and QC control limits for water (rinsate) analyses are given in Table AQAP-8 and AQAP-9, and are discussed further in Section 4.

3.4.1 Limits of Detection (LODs)

As defined in the DoD QSM (DoD 2013), Appendix D, Section D1.2.1, the LOD is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. LODs are determined through a study following the requirements in 40 Code of Federal Regulations (CFR) 136, Appendix II.

3.4.2 Limits of Quantitation (LOQs)

As defined in the DoD QSM (DoD 2013), Appendix D, Section 1.2.2, the LOQ represents the value for which the laboratory has demonstrated the ability to reliably quantify target analytes within a prescribed performance criteria for the method performed. Operationally, the LOQ is equivalent to or greater than the concentration of the lowest calibration standard in the initial calibration curve.

[1] Note that the LOD and LOQ defined in this QAPP are equivalent to Method Detection Limits (MDL) and Method Report Limits (MRL), respectively.

Sample-specific LOQs for an individual sample will be adjusted according to the percent moisture (for dry-weight-basis sample result reporting), sample/extract volume used for the analysis, sample matrix effects (if any), and dilution(s).

As required by the DoD QSM (DoD 2013), all laboratory analytical results will be evaluated and reported down to the LODs; concentrations reported below the LOQs but above the LODs will be qualified as estimated values (J-flag assigned) by the laboratory; these values can only be used as semi-quantitative data points.

In cases where the reported LODs and LOQs could not attain to the project required levels specified in this AQAP for specific sample(s) or analyte(s), the laboratory will demonstrate the efforts of best practice to obtain the optimal quantitation limits given the sample matrix or method limitations. For instance, progressive multiple dilutions may be needed for a PAH and/or PCP analysis to ensure reported LODs and LOQs are lowest-possible for each target compound. A one-time dilution for all compounds is not acceptable unless the dilution factor is determined the lowest-possible for the given sample matrix.

4.0 Methods and Quality Control for Field Activities

This section briefly summarizes the field measurement procedures, sample handling, and coordination procedures that are germane to the interactions between field sampling team and analytical laboratory. To generate high quality data during Year 22 monitoring, general field operations and practices, and specific sample collection and inventory must be well planned and carefully implemented. Discussion of this information and the planned monitoring tasks are provided in the 2016 OMMP Addendum and in the PMP. Detailed sampling procedures are presented in the FSP.

4.1 Sampling Procedures

Field sampling protocols are presented in Sections 5.0 through 7.0 of the FSP. Specifically, the following FSP sections pertain to the sampling methods that will be utilized on this project:

- FSP Section 2.2 and Table FSP-1 provide the station locations and the type of samples to be collected
- FSP Section 5.1 provides specific information on navigation and positioning using a DGPS
- FSP Section 5.2 presents the methods for collection of subtidal surface sediment samples for physical and chemical analyses
- FSP Section 5.3 presents the methods for collection, processing, and logging of subtidal sediment core samples
- FSP Section 5.4 presents the methods for collection of surface sediment and core samples for physical and chemical analyses at grids J7, J8, J9, J10, K7, K8, and L8.
- FSP Section 6.0 gives the procedures for field sample activity documentation and chain-of-custody procedures
- FSP Section 7.0 for sample container preparation and shipping

4.2 Field Measurement Instrument Calibration Procedures

The calibration and general maintenance of the instruments used in the field will be the responsibility of the Sediment Technical Lead. All calibration procedures and measurements will be made in accordance with manufacturers' specifications. Field instruments will be checked and calibrated before their use on site.

It is expected that field measurements will include the following:

- DGPS station locating
- Depth to mudline (fathometer and lead line)
- Core logging

A DGPS will be used to navigate to, occupy, and document all over water stations aboard the *R/V Nancy Ann* operated by Marine Sampling Services (MSS). A Trimble AG132 DGPS utilizing the U.S. Coast Guard differential signal from Oak Harbor, Washington, will be interfaced to a computer running software enabling real-time plan view navigation to the required sampling stations. Station coordinates will be digitally recorded and in the field logs at the time of collection of each sample in NAD 83.

Prior to the start of field collections during each day of survey operations, a known horizontal control point will be occupied to ensure the accuracy of the positioning and navigation systems. The horizontal control point will be determined with the USACE, but is currently expected to be the USCG navigational buoy in the northeast of Eagle Harbor. All daily navigation checks are expected to be within ± 2 m. All documentation pertinent to the calibration and/or maintenance of field instruments will be maintained in an active field logbook.

For each station, the time and depth to mudline will be recorded with a fathometer and a hand-held lead line. All depths will be recorded in the field notebook as depth to mudline, but will be converted to depth mean lower low water (MLLW) using the National Oceanic Atmospheric Administration (NOAA) tidal data for Eagle Harbor.

All cores will be logged and photographed. Significant core details will include general soil type based on the USCS, color based on a Munsel color chart, the approximate grain size, presence or evidence of biota (e.g., roots, mollusk shells), presence of other materials (e.g., wood chips or industrial materials), presence of visible hydrocarbon, odor, and color. The hand-written logs will be translated to an electronic core log using the gINT® software system. All e-core logs will be 100 percent hand-checked against the written logs.

4.3 Sample Handling, Containers, Preservation, and Holding Times

Sample containers, preservation, and holding times are summarized in Table AQAP-10. Samples will be collected in glass or plastic containers, depending on the types of analyses. The containers will have screw-type lids to ensure adequate sealing of the bottles. Lids of all containers will have Teflon® inserts to prevent sample reaction with the lid and to improve the quality of the seal. Commercially available pre-cleaned jars will be used (e.g., I-Chem or similar).

Sample preservation procedures are used to maintain the character of analytes as sampled (i.e., representative concentrations and/or speciation in situ) during storage and shipment. Sediment samples collected for this investigation will be preserved by cooling to 4°C ±2° C and may also be frozen. Sample preservation techniques are presented in Table AQAP-10.

Samples will be placed in the appropriate sample container, preserved, and refrigerated (on ice in a cooler) immediately after sample collection. The samples will be transferred to the laboratory as soon as possible using chain-of-custody (CoC) procedures, as described in Sections 6 and 7 of the FSP. Based on the potential levels of contaminants, samples for all analyses will be hand-delivered or shipped as environmental samples.

Upon receipt of coolers at the investigation laboratory, a cooler receipt form will be completed to document sample condition. The laboratory will complete and submit a cooler receipt form for each investigation cooler. The form will describe the condition of custody seals, errors, or inconsistencies on the CoC form and bottle labels, packing materials, the temperature of the samples, the condition of the sampling containers, the appropriateness of the sample preservation, and the adequacy of the sample aliquots submitted. The laboratory will transmit the CoC and cooler receipt forms to the project manager and data QA officer within 24 hours of sample receipt.

Should any anomalies associated with sample integrity (e.g., sample breakage, sample ID confusion) occur or are identified upon sample receipt at the laboratory, the laboratory should immediately notify the HDR project manager and data QA officer. The findings and resolution will be documented in the Sample Receipt Form. The laboratory will make every effort to meet all specified holding times. In case of a holding time exceedance, the laboratory project manager should contact the HDR project manager and the data QA officer immediately for resolution. The incident and resolution should be documented and reported in the case narrative along with original communication records.

4.4 Coordination with Analytical Laboratory

The sediment technical lead and data QA officer will work directly and closely with the laboratory project manager prior to and during the course of field activities. The sediment technical lead will coordinate logistic and sample transit needs and procedures with the laboratory. The data QA officer is responsible for review of day-to-day sample custody and receipt confirmation provided by the laboratory, and act as a project liaison to coordinate all project needs and communications with the analytical laboratory.

5.0 Methods and Quality Control for Laboratory Activities

This section describes the analytical procedures to be used for investigation laboratory measurements. The analytical methods and associated QA/QC procedures were selected based on consideration of the investigation DQOs.

5.1 Analytical Laboratories

The chemical analyses of investigation sediment samples will be performed by ARI. The laboratory project manager and contact information are as follows:

ARI
Laboratory Project Manager Cheronne Oreiro
4611 S 134th Pl # 100
Tukwila, WA 98168-3212
Phone: (206) 695-6214
email: cheronne@arilabs.com

The chemical analyses of tissue samples will be conducted by EPA's laboratory in Manchester, Washington. The EPA laboratory project manager and contact information are:

EPA Manchester Laboratory
Laboratory Project Manager Gerald Dodo
7411 Beach Drive East
Manchester, WA 98353
Phone: (360) 871-8728
dodo.gerald@epa.gov

The discussion below pertains only to analyses of sediments and water samples at ARI. QA/QC procedures for clam tissue analyses at the EPA laboratory are covered separately in Appendix A of the FSP.

5.2 Laboratory Sample Handling and Custody

The Sediment Technical Lead will arrange for sediment samples to be shipped or delivered to ARI. The samples are deemed under ARI custody at the point the samples arrive at the laboratory and are signed for by an authorized representative of ARI on the CoC form accompanying the samples. ARI will carry full responsibility of maintaining sample integrity from this point toward the end of sample archiving period, as determined in writing by the project manager.

5.2.1 Sample Custody

The sample custodian at each laboratory will accept custody and log samples into the Laboratory Information Management System (LIMS). The sample custodian will check that the CoC forms were properly completed and signed, that a sample receipt form is completed for each cooler, and that samples are stored under the required temperature conditions. The laboratory will deliver a copy of the CoC and sample receipt form to the project manager and data QA officer. Any breaks in the CoC or nonconformance will be noted and reported in writing to the data QA officer within 24 hours of receipt of samples. The laboratory should follow requirements stated in Section 4.3 in cases of sample integrity non-conformance.

Upon receipt by the laboratory, the sample custodian will follow these procedures:

- Check for custody seals and ensure that they were placed at two locations on the outside of the shipping container.
- Date and sign the chain-of-custody form, airbill, and any other documents using full signature.
- Open each cooler, place a thermometer inside the temperature blank (see Section 10.1.3) until the temperature stabilizes, and record the cooler's temperature on the sample analysis form.
- Remove all sample containers from coolers and check for breakage.
- Compare sample identification numbers and number of bottles to the chain-of-custody form. All discrepancies in chain-of-custody, analysis requested, number of bottles, etc., will be recorded on the chain-of-custody form and laboratory database (i.e., LIMS).
- The laboratory shall complete a cooler receipt form and submit the original to HDR. ARI shall provide the completed original chain-of-custody to HDR for inclusion in the evidence files. The EPA laboratory shall provide a copy of the completed chain-of-custody to the USACE; the original chain-of-custody forms will be retained by EPA.
- Log samples into the LIMS. Record date and time of sample collection, date received, turn-around-time, name of person logging the job, client code, client project number and name, ARI job number, number of jars, sample matrix, requested analyses, method of sample delivery, the airbill number (if applicable), and integrity of samples received (including cooler temperature).
- After admitting the samples, log them into the appropriate lab refrigerators. Custody has been relinquished as soon as samples are logged into appropriate lab refrigerators.

The laboratories will follow their documented in-house chain of custody procedures when handling samples for this project. This will include procedures to ensure that samples are secure and that chain of custody is maintained.

For sediments and water, chain-of-custody records will be retained by HDR and ARI and are the responsibility of the laboratory project manager. A copy of the record will be included in the data deliverable to HDR.

5.2.2 Laboratory Internal Sample Custody

The laboratory project manager will ensure that a sample-tracking record is maintained that follows each sample through all stages of laboratory processing. The sample-tracking record must contain, at a minimum, the names of individuals responsible for performing the analysis; dates and times of sample extraction, preparation, and analysis; and the type of analysis being performed.

Any sample needing further analysis that is not performed by the initial contracted laboratory will be subject to all custody specifications provided in the previous section.

5.2.3 Archived Samples

Archive samples will be collected from each of the individual subtidal sediment grab sample locations (i.e., those grab samples being used to form the composite sample for chemical analysis). Up to 16-ounces of sediment will be collected for archiving for samples that are scheduled for analysis, as available. In addition, any sample remaining in the sample jars after aliquots are removed for analysis by the laboratory will be archived.

All archive samples will be submitted to EPA's Manchester Laboratory for management. Sample aliquots for chemical analyses will be stored at -20±2°C; it will not be required to maintain sample aliquots for grain size or total solids analyses. Sediment remaining after analysis will be archived by the laboratory that completed the analysis. The laboratories will maintain internal CoC documentation and proper storage conditions for the entire time that the samples are in their possession. EPA's Manchester Laboratory will store the archive and excess samples for 12 months following the completion of data evaluation and validation. Disposal of excess and archived samples will be approved by the USACE project manager, or her designee, in writing prior to the disposal.

5.3 Analytical Methods

The analytical methodologies, procedures, and QC measurements and criteria follow current analytical protocols in the following documents:

- *Test Methods for Evaluating Solid Waste (SW-846)* (EPA 1998 and updates)
- DoD QSM (DoD 2013)
- *Methods for Chemical Analysis of Water and Wastes* (*MCAWW*) (EPA 1983)
- *Procedures for Handling and Chemical Analysis of Sediment and Water Samples* (Plumb 1981)
- *Puget Sound Estuary Protocols* (PSEP 1997)
- *Annual Book of ASTM Standards*

Sample extraction, cleanup, and analysis methods for sediments are specified in Table AQAP-5. Sections 5.3.1 through 5.3.8 briefly describe key procedures applied to the chemical analyses on the investigation samples.

5.3.1 Total Organic Carbon (TOC)

TOC will be analyzed with the methodology published by Plumb in 1981, as recommend in the Puget Sound Estuary Program (PSEP) protocols. An aliquot of the sample is pre-treated with phosphoric acid to liberate inorganic carbon (principally carbonate). The pretreated aliquot is then oxidized in an oven at approximately 850°C to convert carbon to carbon dioxide (CO_2), the converted CO_2 is then measured via infrared spectrophotometry. Results are expressed in terms of carbon per dry weight of the un-acidified sample.

5.3.2 Grain Size

Grain size by the pipette and wet sieve method following the Puget Sound Estuary Program (PSEP). Wet sieve analysis will be used for the sieve sizes U.S. No. 4, 10, 18, 35, 60, 120, 200, and 230. Hydrogen peroxide will not be used in preparations for grain size analysis. (Hydrogen peroxide breaks down organic aggregates and its use may result in overestimation of the percent fine particles found in undisturbed sediment). Pipette analysis will be used for particles finer than the 230 sieve. The 230 sieve is recognized as the break between very fine sand and coarse silt (PSWQAT 1986).

5.3.3 Percent Solids

All analytical data will be reported on a dry-weight basis. Moisture content determination will be performed following SM2540 G-97. Samples will be oven-dried at 103-105°C to a constant dry weight. Gravimetric water content will be calculated as weight of water divided by total dry weight.

5.3.4 Mercury

Cold vapor atomic absorption spectrometry (CVAAS) will be used for mercury analyses. Mercury in sediment and water samples will be extracted with sulfuric acid, nitric acid and oxidized potassium permanganate into solutions per SW846-7470/7471. Sample solutions will then be analyzed with CVAAS.

5.3.5 Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs will be analyzed by gas chromatography/mass spectrometry (GC/MS) following SW-846 Method 8270D. A Selective Ion Monitoring (SIM) mode for the matrix spike (MS) will be used for PAHs identification and quantitation to achieve lower detection limits. The Microwave method (SW-846 Method 3546) will be used for sediment sample extraction; water samples will be extracted with continuous liquid-liquid extraction (SW-846 Method 3520C). Cleanup options will be employed at the discretion of the senior/supervisory analytical chemist. One additional procedural modifications is that the sample primary extract will be dried over silica gel and anhydrous sodium sulfate (Na_2SO_4).

To control the quality of laboratory analysis of samples, established preservation and storage measures will be followed. Recommended sample sizes, sample containers, preservation techniques, and maximum holding times for these analyses are presented in Table AQAP-9.

5.3.6 Pentachlorophenol (PCP)

PCP analysis will be completed with GC/MS using large volume injection (LVI) sample introduction technique for optimal detection limits. Sediment samples will be extracted with ultrasonic extraction technique (SW-846 Method 3550C). Cleanup options will be employed at the discretion of the senior/supervisory analytical chemist. Cleanup options may include gel permeation chromatography (GPC) cleanup (SW-846 Method 3640A) prior to instrumental analysis. Water samples will be extracted with the separatory funnel extraction technique (SW-846 Method 3510C).

5.4 Laboratory Performance

The laboratory will ensure the quality of results by maintaining an integrated QA system of activities involving the planning, implementation, assessment, reporting, and quality improvement of data. These activities will be performed or facilitated by the laboratory QA officer and will include the (1) performance of periodic audits (system and technical); (2) participation in proficiency testing programs/inter-laboratory comparisons, (3) routine analysis of certified reference materials or second source reference materials, and (4) monitoring method performance (sensitivity, precision and bias) through an evaluation of batch QC samples (method blank, laboratory control samples [LCS]) control ranges/charts.

The selected methods and QC requirements listed in this section are sufficient to meet the investigation objectives. Although a best effort will be made to achieve the investigation objectives, there may be cases for which it is not possible to meet the specified goals. Any significant limitation to data quality caused by analyses that fail to meet the data quality indicators (DQIs) specified in this

AQAP will be identified and brought to the attention of the data QA officer, the HDR and USACE project managers, and the USACE technical lead.

5.4.1 Quantitation Limits

The laboratory must ensure that all possible procedures for achieving minimum reporting limits are applied as specified in Tables AQAP-3 and AQAP-4. These procedures may include sample cleanup, increased aliquot size, and concentration of extracts. Due to the significant analytical method modification to achieve the low-level detection limits required by this project, some reporting limits may not follow the QSM requirement of LOQ greater than three (3) times the LOD. In addition, the laboratory will report (as estimated) all detected compounds with concentrations below the LOQs but above the LODs. If dilutions are necessary to bring individual target analytes within the calibration range, these analytes will be reported from the dilution whereas the remaining analyte results will be reported from the non-diluted analytical run.

5.4.2 Laboratory Control Samples (LCSs)

If target analytes in LCSs are out of control limits, corrective action will be taken. Initially, the effect the QC failure has on the samples will be evaluated. Regardless of the results of this assessment, the laboratory will take steps to find the source of the problem and correct it. Typically, the laboratory will reanalyze the LCS for the failed analytes only. If the second analysis fails, the LCS, method blank, and all associated samples of the batch will be re-prepared and reanalyzed for the failed analytes only. When there are multiple target analytes (more than five), sporadic marginal failures of a few target analytes included in the LCS may be acceptable without requiring reanalysis of the entire batch. The control limits for LCS in various analytical methodologies are summarized in Tables AQAP-6 through AQAP-9. Note that the LCS control limits specified in this AQAP were based on the most current laboratory performance-based charted values. The QSM recommended control limits were not adopted because analytical methods used in this investigation were significantly modified from the regular QSM referenced methods in order to achieve low-level detection limits required by this investigation.

5.4.3 Blanks

The DoD QSM (DoD 2013) states that the method blank is acceptable if “the concentration of all target analytes is below one-half the LOQ for each target analyte, or less than 5 percent of the regulatory limit associated with that analyte, or less than 5 percent of the sample result for the same analyte, whichever is greater.” The laboratory will be required to comply with this USACE guidance as follows:

- If an analyte is found only in the method blank, but not in the batch samples, no further corrective action is necessary.
- If an analyte is found in the method blank at concentrations that exceed criteria, and in some or all of the other batch samples, the laboratory will reanalyze (within the holding times) the method blank and any samples containing the same contaminant.
- If the contamination remains at concentrations that exceed criteria, the laboratory will re-prepare and reanalyze (within the holding times) the contaminated samples, a new method blank, and batch-specific QC samples.

If holding times are exceeded before reanalysis occurs, the laboratory must notify the HDR project manager and data QA officer immediately for optimal resolutions.

5.4.4 Compound Identification

Laboratory requirements for compound identification are prescribed within the EPA (1998) analytical methods used. In some organic methods, the information is included directly within the method (e.g., GC/MS Method 8270D), or this information is referenced to a general EPA (1998) method (such as 8000B) that outlines procedures applicable to several chromatographic methods (e.g., GC). Laboratory SOPs present procedures required to establish retention time windows (window width and location) for each target analyte for each chromatographic column used in the analysis.

Laboratory requirements for compound confirmation are prescribed within the EPA (1998) analytical methods used. For GC/MS methods, compound confirmation is obtained from the mass spectrum following specified procedures included within the methods, and no additional measures are needed. For GC methods, procedural options are presented in Method 8000B, Section 7.9, and include the use of the GC/MS or other analytical technique (if applicable), a dissimilar column (if available), or a second detector as a means for confirmation. When a secondary column is used, SW-846 Method 8000C, Section 7.9, states that the analysis must meet the QC criteria (for example, for calibration or retention time).

When confirmed, the agreement between the primary and secondary columns (or detectors) is compared to evaluate method performance and decide the value to report (if applicable). The difference between the results is calculated as the relative percent difference (RPD) for comparability purposes only. These RPD values are generally not used to determine the presence or absence of the target analyte. Presence or absence is determined by the signal being present above method criteria on both columns. When disparity in the results occurs, the laboratory must review the chromatograms to evaluate potential sources of error (such as overlapping peaks or matrix interference). When no evidence of interference is found, the larger of the values will be reported to ensure that any decisions made based on the data are conservative with regard to the environment.

5.4.5 Laboratory Performance Oversight

The procedures described in the subsequent paragraphs will be instituted to ensure that the data comply with investigation-specific QC criteria as presented in this AQAP.

The laboratory will receive copies of the final QAPP, including this AQAP, to furnish resources required to meet all the requirements in these documents. The laboratory is required to transmit to the HDR project manager and data QA officer the completed and signed CoC forms and cooler receipt forms via e-mail or facsimile as described in Section 4.3. The HDR project manager and data QA officer will review the forms and confirm the adequacy and completeness of the requested analyses, evaluate sample receiving conditions, and take corrective action as needed.

The laboratory will notify the data QA officer within 24 hours should any anomalies occur in relation to sample receiving, handling, preparation, and analysis during the entire course of the project. The data QA officer is responsible for, in a timely manner, notifying and resolving reported nonconformities and/or follow the chain-of-command up to the HDR and USACE project managers for ultimate corrective actions.

Preliminary analytical results (Contract Laboratory Program [CLP] Form-1) and the results of the laboratory QC analysis will be transmitted to the project manager and data QA officer within 15 business days after the last sample arrives at the laboratory for an analytical batch for all analyses including PAHs. The data QA officer is responsible for reviewing the Form-1s for holding time, target analyte list, and LOD/LOQ compliance with requirements stated in this AQAP.

A Level II B verification and validation will performed on 100 percent of the PAH final laboratory data packages by the data QA officer. In addition, 10 percent of the PAH data packages will subject to a full (Level IV) validation.

Any discrepancy or anomalies identified will be resolved with the laboratory immediately, or follow the chain-of-command up to the HDR and USACE project managers for adequate corrective actions.

6.0 Field and Chemistry Laboratory Quality Control Samples

QC samples are controlled samples introduced into the analysis stream, the results of which are used to assess data quality and to calculate the accuracy and precision of the chemical analysis program. The purpose of each type of QC sample, collection and analysis frequency, and evaluation criteria are described in this section. Collection frequencies for field QC samples are summarized in Table AQAP-11.

QC procedures for the analytical laboratories will be consistent with the requirements described in the analytical methods and this AQAP. The laboratory will be required to conduct all QC measurements on samples from this investigation in each sample preparation batch. QC analyses performed on non-project samples will not be reported in addition to those on the project samples.

6.1 Field Quality Control Samples

Field QC is accomplished through the analysis of controlled samples that are introduced to the laboratory from the field. Field duplicates, and temperature blanks will be collected and submitted to the investigation laboratory to provide a means of assessing the quality of data resulting from the field sampling program. Field quality control samples will be run based on two sample groups: (1) the EBS surface sediment samples, and (2) the subtidal surface samples from grids, J7, J8, J9, J10, K7, K8, and L8. Frequency of analyses for these two groups is discussed, below. Field quality control samples for clam tissue residue samples are discussed in Appendix A of the FSP.

6.1.1 Equipment Rinsate Blanks

Rinsate blanks are collected to determine the potential for cross-contamination of samples between sampling locations and samples. At a minimum, one rinsate blank will be collected using distilled water provided by the laboratory for each sampling technique.

One (1) rinsate will be collected during EBS sediment sampling and analyzed for PAHs; and one (1) rinsate will be collected during the subtidal grid sampling and the rinsate analyzed for the for PAHs.

6.1.2 Field Duplicates

Field duplicate samples are used to check for sampling and analysis reproducibility. Field duplicate samples will be collected at a frequency of 20 percent of the sediment field samples. Field duplicate samples will be collected in conjunction with and analyzed by the same methods as the primary samples. Field duplicate samples will be collected from areas most likely to be contaminated and will be submitted blind to the laboratory, with sample numbers that are indistinguishable from the primary sample numbers. Control limits for field duplicate precision are 50 percent RPD for sediment samples. Calculation and reporting of the RPD for field duplicates are described in Section 9.1.

One (1) field replicate will be collected with the EBS sediment samples and analyzed for PAHs, PCP, grain size, and TOC. One (1) field replicate will be collected from the composite subtidal surface samples and analyzed for PAHs, PCP, mercury, grain size, and TOC.

6.1.3 Temperature Blanks

Temperature blanks are used to supplement the determination of cooler temperatures upon receipt of the coolers at the laboratory. One temperature blank will be prepared using a 500-mL high density polyethylene (HDPE) bottle with analytical-grade distilled (DI) water and submitted to the investigation laboratory with each cooler. The temperature blank will be packed on ice in the cooler in the same manner as the rest of the samples and labeled “temperature blank.” All sample coolers must have a temperature blank included.

6.2 Laboratory Quality Control Samples

Laboratory QC is accomplished by analyzing initial and continuing calibration samples, method blanks, surrogate spikes, LCSs, matrix spikes and matrix spike duplicate (MS/MSD) pairs, and laboratory duplicate samples. A listing of the required laboratory QC samples is given in Table AQAP-10. Investigation-specific QC criteria (including frequency, QC limits, and corrective actions) are presented in Table AQAP-7 and Table AQAP-8. The required laboratory quality assurance samples are summarized in Table AQAP-12.

6.2.1 Initial and Continuing Calibration Standards

Laboratory instrument calibration and maintenance requirements are discussed in Section 8.

6.2.2 Blanks

Method blanks are used to check for laboratory and reagent contamination, instrument bias, and accuracy. Laboratory method blanks will be analyzed at a minimum frequency of 5 percent or one per analytical batch for all chemical parameter groups.

QC criteria require that minimum contamination be detected in the blank. If a chemical is detected, the action taken will follow the criteria established by this AQAP. Blank samples will be analyzed for the same parameters as the associated field samples. The concentrations of analytes detected in the method blanks will not be subtracted from the sample concentrations.

6.2.3 Surrogate Spikes

Surrogate compounds are compounds that are unlikely to be detected in environmental samples; but chemically similar to target compounds. For all organic analyses (e.g., PAHs and PCP), surrogate compounds required by the respective methods will be added to all field and QC samples and processed through the entire sample preparation and analysis procedures.

Percent recovery of surrogates is calculated concurrently with the analytes of interest. The percent recovery is a measure of accuracy of the overall sample preparation and analysis procedures.

6.2.4 Laboratory Control Samples (LCS), LCS Duplicate (LCSD), and Standard Reference Material (SRM)

LCSs are prepared and analyzed in each sample preparation batch to monitor the laboratory’s day-to-day performance of routine analytical methods, independent of matrix effects. LCSs associated with water samples are prepared by spiking reagent water with standard solutions containing all target compounds. Spiking levels will be between the low- and mid-level calibration standards. Standard reference materials (SRM) will be used, instead of blank spikes, in lieu of LCS/laboratory control sample duplicate (LCSD) for sediment analyses. The RPD value for LCS and LCSD allows the evaluation of laboratory precision. Should any LCS recovery outliers occurs, corrective actions will be taken in accordance with the DoD QSM, Appendix DOD-B (DoD 2013).

6.2.5 Matrix Spike (MS) and MS Duplicate (MSD)

Matrix spike/matrix spike duplicates (MS/MSD) sample pairs are used to assess the magnitude of effects by a specific sample matrix on analytical accuracy and precision. Known concentrations of target analytes are added to aliquots of the selected project sample(s); the spiked aliquots are then processed through the entire preparation and analysis procedures. The percent recovery of the spiked amounts and the RPD value between the MS and MSD are calculated. The percent recovery is used for the evaluation of sample matrix-specific accuracy and the RPD value for the precision.

The sample for MS/MSD analyses will be designated in the field and will be collected from a location with the estimated lowest concentrations of target analytes so that the added spike compounds are not masked by the sample analyte concentrations. Required laboratory QC criteria for MS/MSD sediment samples are provided in Tables AQAP-6 and AQAP-7.

One sample will be selected for MS/MSD analyses from the EBS sediment samples for PAHs analyses only. One (1) sample will be selected for MS/MSD analyses from the subtidal surface samples for PAHs analyses only.

6.2.6 Laboratory Duplicate Samples

Precision of the analytical system is evaluated by analyzing MS/MSD pairs and laboratory duplicates. Laboratory duplicates are two portions of a single homogeneous sample analyzed for the same parameter. Laboratory duplicates will be prepared and analyzed with investigation samples being analyzed for metals and other inorganic analytes. If a sample contains high native concentrations of organic compounds, a laboratory duplicate (instead of MSD) will be analyzed.

7.0 Laboratory Instrument Calibration

Instrument calibration will be in compliance with (1) respective analytical methods, (2) this AQAP, and (3) the Laboratory Quality Assurance Manual. General requirements are discussed below.

7.1 Standard Solutions

A critical element in the generation of quality data is the purity/quality and ability to trace the standard solutions and reagents used in the analytical operations. To ensure the highest purity possible, the laboratory will obtain all primary reference standards and standard solutions from the National Institute of Standards and Technology (NIST), the EPA repository, or other reliable commercial source. The laboratory will maintain a written record of the supplier, lot number, purity/concentration, receipt/preparation date, name of the analyst, method of preparation, expiration date, and all other pertinent information for all standards, standard solutions, and individual standard preparation logs.

Standard solutions will be validated prior to use. Validation procedures can range from a check for chromatographic purity to verification of the concentration of the standard solution using another standard solution prepared at a different time or obtained from a different source. Stock and working standard solutions will be checked regularly for signs of deterioration, such as discoloration, formation of precipitates, or change of concentration. Care will be exercised in the proper storage and handling of standard solutions, and all containers will be labeled as to compound, concentration, solvent, expiration date, and preparation data (with initials of preparer and date of preparation). Reagents will be examined for purity by subjecting an aliquot or subsample to the corresponding analytical method.

7.2 Balances

The laboratory will calibrate analytical balances annually according to manufacturer’s instructions and make a calibration check before each daily use by laboratory personnel. All balance calibrations will use Class 1 or S weights and will be within a range appropriate to the sample mass. Acceptance criteria are 1 percent for top-loading balances and 0.1 percent for analytical balances. Annual calibrations and calibration checks will be documented in appropriate hardbound logbooks with pre-numbered pages.

7.3 Refrigerators

The laboratory will monitor all refrigerators for proper temperature by measuring and recording internal temperatures on a daily basis using NIST-certified or NIST-traceable thermometers. At a minimum, thermometers used for these measurements will be calibrated annually according to manufacturer’s instructions. Refrigerators will be maintained at 4°C ±2° C and freezers at −10° C to −20° C. Refrigerator and freezer temperatures will be documented in appropriate hardbound logbooks with pre-numbered pages.

7.4 Volumetric Measurements

Before use, volumetric glassware or other laboratory ware will be inspected for cracks or damages. Eppendorf-type pipettes will be verified (weekly, at a minimum) at the volume to be used or at two different volumes that bracket the range of use. Fixed-volume Eppendorf-type pipettes will be verified monthly. All nonstandard laboratory ware used to measure the initial sample volume or the final volume of the extracts/digestates will be verified to be accurate within 3 percent. Each calibration check will be documented in appropriate hardbound logbooks with pre-numbered pages.

7.5 Water Supply System

The investigation laboratory will maintain an appropriate water supply system that is capable of furnishing ASTM International (ASTM) Type II polished water to the various analytical areas. ASTM Type I or equivalent water will be used for trace metal analysis.

Initial calibration blanks and continuing calibration blanks will be used to document that the laboratory water supply system produces water that is free of the analytes of interest at the level of concern for the investigation. Method blanks will be used to ensure that none of the reagents used for the requested analyses are contaminated with the analytes of interest.

7.6 Laboratory Instruments

As stated in laboratory SOPs, calibration of all analytical instrumentation is required to ensure that the analytical system is operating correctly and functioning at the sensitivity required to meet investigation-specific objectives. Each instrument will be calibrated with standard solutions appropriate to the instrument and analytical method, in accordance with the methodology specified, and at the QC frequency specified in the laboratory SOPs.

The calibration history of the fixed laboratory instrumentation is an important aspect of the investigation's overall QA/QC program. Therefore, all initial and continuing calibration procedures will be implemented by trained personnel following the manufacturer's instructions and in accordance with applicable EPA protocols to ensure the equipment is functioning within the tolerances established by the manufacturer and the method-specific analytical requirements.

7.7 Analytical Laboratory Calibration Procedures

All instrument performance checks (i.e., instrument tuning for mass spectrometers), initial calibrations (including second source initial calibration verification), and continuing calibration verifications will comply with:

- EPA SW-846 and respective analytical methods (EPA 1998 and updates)
- DoD QSM (DoD 2013)
- ARI SOPs
- ARI Laboratory Quality Assurance Manual.

8.0 Analytical Data Quality Indicators

The quality and usability of data collected in this investigation will be determined, based on the outcomes of data verification and validation, and expressed as DQIs - precision, accuracy (bias), representativeness, comparability, completeness, and sensitivity evaluated as indicated in Table AQAP-13 and the subsequent discussion. Tables AQAP-6 through AQAP-9 present a summary of QC samples and parameters corresponding to each of the DQIs.

The definition of the DQIs is discussed in the following sections.

8.1 Precision

Precision is defined as the degree of agreement between or among independent, similar, or repeated measures. Precision is expressed in terms of analytical variability. For this investigation, analytical variability will be measured as the RPD or coefficient of variation between analytical laboratory duplicates and between the MS and MSD analyses. Monitoring variability will be measured by analysis of blind field duplicate samples.

Precision will be calculated as the RPD as follows:

$$RPD\ (\%) = 100 \times \frac{|S - D|}{(S + D)/2}$$

where:

S = analyte concentration in a sample
D = analyte concentration in a duplicate sample

The resultant RPD will be compared with criteria established by this AQAP, and deviations from these criteria will be reported. If the AQAP criteria are not met, the laboratory will supply a justification of why the limits were exceeded and implement the appropriate corrective actions. The RPD will be evaluated during data review and validation. The data reviewer will note deviations from the specified limits and will comment on the effect of the deviations on reported data.

8.2 Accuracy

Accuracy is the amount of agreement between a measured value and the true value. It will be measured as the percent recoveries of MS and MSD, organic surrogate compounds, and the LCS. Additional potential bias will be assessed using calibration standards and blank samples (e.g., method blanks).

In cases where accuracy is determined from spiked samples, accuracy will be expressed as the percent recovery. The closer these values are to 100, the more accurate the data. Surrogate recovery will be calculated as follows:

$$\text{Recovery}\ (\%) = \frac{MC}{SC} \times 100$$

where:

SC = spiked concentration
MC = measured concentration

MS percent recovery will be calculated as follows:

$$\text{Recovery (\%)} = \frac{MC - USC}{SC} \times 100$$

where:

SC	=	spiked concentration
MC	=	measured concentration
USC	=	unspiked sample concentration

The resultant percent recoveries will be compared with criteria established by this AQAP, and deviations from these criteria will be reported. If the objective criteria are not met, the laboratory will supply a justification of why the limits were exceeded and implement the appropriate corrective actions. Percent recoveries will be evaluated during data review and validation, and the data reviewer will comment on the effect of the deviations on the reported data.

8.3 Representativeness

Representativeness is the degree to which sample results represent the system under study. This component is generally considered during the design phase of a program. This program will use the results of all analyses to evaluate the data in terms of its intended use. Site sampling locations for this investigation are placed using a biased approach to maximize the likelihood of locating and identifying site contamination. Areas of apparent contamination have been selected to be representative of potential impacts from past activities. Representativeness will also be determined by evaluating hold time, sample preservation, and blank contamination. Samples with expired hold times, improper preservation, or contamination may not be representative.

8.4 Comparability

Comparability is the degree to which data from one study can be compared with data from historical studies at the site, other similar studies, reference values (such as background), and reference materials. This goal will be achieved through the use of standard techniques to collect samples, EPA-approved methods to analyze samples, and consistent units to report analytical results. Data comparability also depends on data quality. Data of unknown quality cannot be compared.

8.5 Completeness

The basis for evaluation of the analytical data will be the DQIs contained in this section, and guidelines established by the USEPA Contract Laboratory Program (CLP) National Functional Guidelines (EPA 2015 a,b). Quality data are data that fulfill the DQO requirements established in these documents. Completeness for quality data (percentage of quality data out of the total data set generated) for Year 22 monitoring will be greater than or equal to 95 percent. Data will be rejected if these criteria are not met and no documented corrective actions have been taken. Rejected data are not usable.

The amount of sample collected will be sufficient to re-analyze the sample should the initial results not meet QC requirements. Because the number of sample aliquots that will be collected to measure each parameter exceeds that required for the analysis, thus allowing for reanalysis, 100 percent completeness is anticipated. Less than 100 percent completeness could result if sufficient chemical contamination exists to require sample dilutions, resulting in an increase in the investigation-required detection/quantitation limits for some parameters. Highly contaminated environments can also be sufficiently heterogeneous to prevent the achievement of specified precision and accuracy criteria. If the corrective actions recommended in the analytical methodology, laboratory SOP, and this AQAP have been applied but investigation-specific QC criteria cannot be met, the data are still usable and the laboratory will flag the data and provide written documentation of the corrective actions taken. Overall investigation completeness will be 95 percent for usable data (defined as the percentage of usable data compared to the total data set generated).

Completeness will be calculated as follows:

$$Completeness\ (\%) = \frac{V}{P} \times 100$$

where:

V	=	number of valid measurements
P	=	number of planned measurements

Valid and invalid data (i.e., data qualified with the R flag [rejected] will be identified during data review and validation (Section 10.2).

8.6 Sensitivity

Sensitivity will be determined by reviewing LODs and LOQs. LOQs will be set low enough to allow meaningful comparisons with screening criteria to the extent possible, taking into account matrix effects. The laboratory will report compounds detected above the LODs and positively identified below the LOQs, as estimated (J-flagged) values.

9.0 Preventive Maintenance

9.1 Preventive Maintenance

Manufacturers have established guidelines for preventive maintenance of their instruments and equipment. Preventive maintenance is implemented on a schedule based on the type and stability of the instruments and equipment, investigation-required accuracy, intended use, and environmental factors. Preventive maintenance minimizes down time and ensures the accuracy, precision, sensitivity, and traceability of data collected while using the instruments and equipment. Maintenance is conducted by trained technicians, using service manuals or through service agreements with qualified maintenance contractors. Instruments and equipment that are identified to be out of calibration or malfunctioning are removed from operation until they are recalibrated or repaired. In addition, backup for instruments/equipment and critical spare parts are maintained to quickly correct malfunctions. Examples of typical equipment maintenance spare parts may include but not be limited to filters, tubing, and fittings.

9.2 Field Instrument/Equipment Calibration and Frequency

Calibration of equipment and instrumentation ensures that accurate and reliable measurements are obtained. All instruments and equipment used on the investigation are calibrated and adjusted to operate within manufacturers' specifications and with a frequency stipulated by the maintenance schedule or by analytical method. Instrument calibration will be conducted at the beginning of each workday and at midday in accordance with manufacturer’s specifications. A final calibration will be conducted at the end of the day after the last field sample has been analyzed. The initial calibration will be conducted in accordance with specific analytical methods and calibration standards if appropriate to the instrument being used. One-point calibrations will be conducted thereafter. In addition, one-point calibrations will be made when sampling conditions change, when sample matrices change, and/or if the instrument readings become unstable.

9.3 Laboratory Instrument Maintenance and Calibration

The procedures for maintenance and calibration used by the analytical laboratory are included in their laboratory QA plans and analytical methods. The laboratory selected for this investigation has demonstrated its ability to analyze investigation samples within holding time by having well-maintained instruments and adequate backup instrumentation.

All laboratory calibration standards must be traceable to the NIST or other primary standards. Methods and intervals of calibration are based on the type of equipment, stability characteristics, required accuracy, intended use, and environmental conditions. Section 6.0 provides detailed requirements for laboratory instruments.

9.4 Calibration and Maintenance Records

Calibration and maintenance schedules and records are maintained for the laboratory’s instruments and field equipment. Both equipment and equipment records are located in a controlled-access facility when not in use. This is done to minimize equipment damage, theft, and tampering that may jeopardize either field or laboratory measurements or, ultimately, data quality.

10.0 Corrective Actions

The investigation plans and training establish the baseline for field quality control. The ultimate responsibility for maintaining quality rests with the project manager. The day-to-day responsibility for ensuring the quality of field and laboratory data rests with the sediment technical lead, data QA officer, and the laboratory program administrator.

Results of QA reviews and audits typically identify the requirement for a corrective action. The data QA officer is responsible for reviewing all audit and nonconformance reports to determine areas of poor quality or failure to adhere to established procedures. Nonconformance is reported formally by the data QA officer to the project manager. The project manager is responsible for evaluating all reported non-conformances, determining the root cause, conferring with the data QA officer on the steps to be taken for correction, and ensuring that the corrective action is developed and scheduled. Corrective action measures are selected to prevent or reduce the likelihood of future occurrences and address the root causes to the extent identifiable. Selected measures are appropriate to the seriousness of the nonconformance and are realistic in terms of the resources required for implementation.

Any nonconformance with the established QC procedures will be expeditiously identified, corrected, and controlled. Where procedures are not in compliance with the established protocol, corrective actions will be taken immediately. Subsequent work that depends on the nonconforming activity will not be performed until the identified nonconformance is corrected.

In summary, corrective action involves the following steps:

- Discovery of a nonconformance
- Identification of the responsible party
- Determination of root causes
- Planning and scheduling of corrective/preventive action
- Review of the corrective action taken
- Confirmation that the desired results were produced.

10.1 Field Corrective Action

The sediment technical lead will review the procedures being implemented in the field for consistency with the established protocols. Sample collection, preservation, labeling, and other procedures will be checked for completeness. Where procedures are not in compliance with the established protocol, the deviations will be field documented and reported to the project manager.

Examples of field nonconformance include, but are not limited to, the following:

- Items provided by a subcontractor supplier that do not meet the contractual requirements
- Errors made in following work instruction or improper work instruction
- Unforeseen or unplanned circumstances that result in services that do not meet quality/contractual/technical requirements
- Unapproved or unwarranted deviations from established procedures

- Sample chain-of-custody missing or deficient
- Data falling outside established objective criteria.

Corrective actions will be defined by the sediment technical lead and project manager with concurrence with the USACE and EPA, and documented. Problems that require corrective action are documented by the use of a corrective action report. Upon implementation of the corrective action, the sediment technical lead will provide the project quality assurance manager with a written memo documenting field implementation. The memo will become part of the investigation file.

10.2 Laboratory Corrective Action

The laboratory quality assurance manager (QAM) will review the data generated to ensure that all samples have been analyzed as specified in this AQAP. Percent recoveries of surrogates and spiked analytes from LCS samples and MS samples will be evaluated for accuracy. RPDs for laboratory duplicate or MSD samples will be evaluated for precision. Corrective action requirements for noncompliant data are presented in the DoD QSM, Appendix DOD-B (DoD 2013) and in the laboratory SOPs.

The laboratory project manager will deliver the CoCs and cooler receipt forms to the project manager within 12 hours of sample receipt. The project manager will be notified immediately if discrepancies occur between the contracted analyses and the analyses listed on the CoCs. The data QA officer will contact the project manager to discuss noncompliant data sets within 72 hours of first discovering that any analysis failed to meet the required data quality criteria. If the analyses cannot produce data sets that are within control limits, the USACE and EPA will be notified. At a minimum, corrective actions are necessary if any of the following occur.

- Initial calibration verification and continuing calibration verification do not meet investigation-specific QC criteria.
- Any changes of LOQs.
- Blanks contain contaminants at concentrations greater than the LOQ for any target analyte.
- The QC data are outside the acceptance windows for precision and accuracy established for LCS.
- Surrogate recoveries are outside the acceptance window for accuracy for organic analysis.
- Undesirable trends are detected in surrogate, MS or LCS recoveries.
- Undesirable trends are detected in RPD for MS/MSD or laboratory duplicates.
- The laboratory QAM detects deficiencies during internal or external audits.

If laboratory personnel identify a nonconformance in analytical methodologies or QC sample results, corrective actions will be implemented immediately. Corrective action procedures will be handled initially at the bench level by the analyst, who will review the preparation or extraction procedure for possible errors and perform various checks such as the instrument calibration, spike, calibration mixes, and instrument sensitivity. The analyst will immediately notify his/her supervisor of the identified problem and the investigation that is being conducted. If the problem persists or the cause cannot be identified, the matter will be referred to the laboratory supervisor and laboratory QAM for further investigation. When the problem has been resolved, the laboratory QAM will file full documentation of the corrective action procedure, and if data are affected, the project managers at HDR, USACE, and EPA will be provided a corrective action memo for inclusion into the investigation file.

Corrective action may include, but will not be limited to, the following.

- Recalibrating analytical instruments.
- Reanalyzing suspect samples if holding time criteria permit. The need for reanalysis is dependent on the number of analytes that are out of compliance, the importance of the outlier to the decision-making process, and the magnitude of the outlying data. For example, an LCS sample with one analyte recovery at 125 percent, representing a sample batch where the average sample concentration was 10 parts per million (ppm), would not necessarily require reanalysis of the LCS or the entire sample batch.
- Resampling and analyzing newly collected samples.
- Evaluating and amending sampling and/or analytical procedures.
- Accepting data with an acknowledged level of uncertainty.
- Evaluating and attempting to identify limitations of the data.

Following the implementation of the required corrective action measures, data still deemed unacceptable will not be accepted by the laboratory project manager and follow-up corrective actions will be explored.

10.3 Corrective Actions Following Data Review

The data QA officer will review the field and laboratory data generated for this investigation to ensure that all investigation QA objectives are met. If any nonconformance in the data has resulted from the field procedures, sample collection procedures, field documentation procedures, or laboratory analytical and documentation procedures, the impact of that nonconformance on the overall investigation QA objectives will be assessed. Appropriate actions, including resampling and reanalysis may be recommended to the project manager so that the investigation objectives can be accomplished.

11.0 Laboratory Data Reduction, Deliverables, Validation, Reporting

This section describes the processes of data generation, reduction, reporting, review, and validation. Data reduction and data quality review responsibilities are summarized in Table AQAP-14.

11.1 Laboratory Data Reduction, Review, and Deliverables

Data generated by the laboratory will undergo generation, reduction, and verification procedures described in the laboratory's QA plans and SOPs.

11.1.1 Data Reduction Procedures

The laboratory will perform in-house analytical data reduction under the direction of the laboratory QAM. Laboratory data reduction procedures will be those specified in EPA-approved methods and those described in the laboratory SOPs. The data reduction steps will be documented, signed, and dated by the analyst. Data reduction will be conducted as follows;

- Raw data produced by the analyst will be processed and reviewed for compliance with investigation-specific QC criteria established in this AQAP. The analyst will also review the raw data for overall reasonableness and for transcription or calculation errors.
- After the data have been entered into LIMS, a computerized report will be generated and sent to the laboratory supervisor or senior chemist.
- The laboratory supervisor will decide whether any sample reanalysis is required. The laboratory project manager will contact the data QA officer to discuss noncompliant data sets upon discovering that any analysis fails to meet the required data quality criteria. If corrective actions have been taken and data still do not meet investigation QA requirements, the USACE and EPA will be notified.
- Upon acceptance of the preliminary reports by the laboratory QA manager, final reports will be generated. Final data reports will be available within approximately 15 business days of sample submittal.

The laboratory analyst will assign QC qualifiers, as described and defined in the laboratory QA plans, if any of the following occurs:

- The concentration of the chemical is below required reporting limit, but is positively identified.
- The chemical is also found in the laboratory blank.
- Spiking analyte recoveries (i.e., bias) are outside investigation-specified control limits (inorganic analyses only).
- Laboratory duplicate precision is outside investigation-specified control limits (inorganic analyses only).

Other sample-specific qualifiers will be added, as necessary, to describe QC conditions.

The laboratory will maintain detailed procedures for laboratory recordkeeping supporting the validity of all analytical work. Each data report package submitted will contain the laboratory's written certification that the requested analytical method was run and that all QA/QC checks were performed. The laboratory program administrators will provide copies of applicable independent third party external audits, which will become part of the central investigation files.

11.1.2 Data Review Procedures

The laboratory analysts have the initial responsibility for verifying the correctness and completeness of the data based on an established set of guidelines and on the investigation-specific QC criteria. The analysts will ensure that the following QC elements have been satisfactorily completed:

- Documentation of sampling receipt and handling is complete.
- Sample preparation information is correct and complete.
- Analysis information is correct and complete.
- Raw data, including manual integrations, have been correctly interpreted; and manual integration will be identified on the chromatograms.
- Appropriate preparation and analysis procedures have been followed.
- Site-specific special sample preparation and analytical requirements have been met.
- Analytical results are correctly calculated and complete.
- QC sample results are within investigation QC limits.
- Laboratory blanks are within investigation QC limits.
- Documentation is complete. All anomalies in the preparation and analysis have been documented; holding times are documented; and all data (including data generated before and after corrective actions or cleanup are conducted) are included in the laboratory data report.

The laboratory supervisor or QAM will provide an independent peer review of the analytical data package to ensure that the following QC elements are acceptable:

- Appropriate laboratory SOPs have been referenced.
- Calibration data are scientifically sound and appropriate to the method.
- QC sample data are within investigation-specific limits.
- Qualitative and quantitative results are correct.
- Raw data, including manual integration, have been correctly interpreted.
- Documentation is complete and correct.

11.1.3 Data Deliverables

To ensure that investigation chemical data are sufficient to meet both qualitative and quantitative objectives, laboratory data deliverables that will permit a data quality assessment consistent with the requirements of this AQAP are required.

The laboratory will prepare and retain full analytical and associated QC documentation. The laboratory will report the data as analytical batches of 20 samples or less, along with associated QC reporting data. The analytical results will be submitted in both hard copy and electronic formats for review by the data QA officer. Data packages will be unbound and paginated.

Information provided will be sufficient to review the data with respect to:

- Holding times and sample conditions
- Calibrations and instrument performance
- Detection/quantitation limits
- Spike and surrogate recoveries
- Duplicate analyses (laboratory duplicates and MS/MSDs)
- LCS
- Blank contamination
- Target compound identification and quantitation
- Analytical system performance

The analytical data will be provided in a complete CLP-type deliverable data format including the following hard copy information for each analytical data package.

- Cover sheet listing the samples included in the report.
- Narrative comments describing problems encountered in analysis, identification of any analyses not meeting quality control criteria, including holding times, and cautions regarding non-quantitative use or unusable data due to out-of-control-limit QC results.
- CoC forms and cooler receipt forms.
- Documentation of extraction, clean-up, and analytical methods used.
- Tabulated results of inorganic and organic compounds identified and quantified, with analyte-specific LODs and LOQs. All analytes will be reported for each sample as a detected concentration or as not detected above the specific limits of quantitation, which must be stated. The laboratory will also report, dilution factors, date of extraction, extraction batch, cleanup procedures used, date of analysis, surrogate percent recoveries, batch run logs, and analytical batch number for each sample, with corresponding sample results. All sediment data are to be reported as dry weight and the percent moisture must be provided.
- Analytical results for QC sample spikes, laboratory duplicates, initial and continuing calibration, verifications of standards and laboratory blanks, standard procedural blanks, LCSs, laboratory reference materials, ICP interference check samples, and detection limit check samples.
- Documentation of rationale for the use of method of standard addition if required.
- Raw data system printouts (or legible photocopies) identifying date of reported analysis, analyst, parameters analyzed, calibration curves, calibration verifications, second column confirmations, method blanks, any reported sample dilutions, cleanup logs, laboratory duplicates, spikes, control samples, sample spiking levels, preparation/extraction logs, run logs, and chromatograms.
- Chromatograms labeled with analyte peaks, internal standards, and surrogate standards where applicable.
- Mass calibration and mass spectral tuning data for GC and GC/MS analyses.

Data reduction and QC review steps will be documented, signed, and dated by an authorized laboratory representative. Corresponding to each individual laboratory report, an electronic data deliverable (EDD) will be prepared in Ecology's Environmental Information Management (EIM) format, and Automated Data Review (ADR) (latest version; A1/A3) format. The ADR EDDs will pass the ADR Checker and the checker reports submitted along with the laboratory data package. The analytical results will be uploaded into Ecology's EIM database once validation is complete.

11.2 Data Review and Data Validation

The purpose of the data validation is to eliminate unacceptable and minimize suspect analytical data and to designate a data qualifier for any data quality limitation discovered. A formal data validation will be performed by the data QA officer and will include a review of laboratory performance criteria and sample-specific criteria. The data QA officer shall determine whether the measurement performance criteria have been met, and will calculate the data completeness for the project.

A Level II B data verification and validation will be performed on 100 percent of the final laboratory PAH data packages by the data QA officer. In addition, 10 percent of the PAH data packages will subject to a full (Level IV) validation. Data will be appropriately labeled according to the level of validation.

The data will be evaluated using QC criteria specified in the analytical methods, *DoD Quality System Manual for Environmental Laboratories (DoD QSM) Version 4.2* (DoD 2013), and this AQAP. Validation will be performed using the following guidance:

- EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (EPA 2015a)
- EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review (EPA 2015b).

The data validation will examine and verify the following parameters against criteria set forth in this AQAP:

- Sample management and holding times
- Instrument tuning, calibration, and calibration verification
- Laboratory and field blank results
- Detection and reporting limits
- Laboratory replicate results
- MS/MSD results
- LCS and/or standard reference material results
- Filed QC sample results
- Surrogate spike recovery (organic analyses only)
- Internal standard recovery (internal calibration methods only)
- Inter-element interference check (ICP analyses only)
- Serial dilution (metals only)

Final data qualifiers will be assigned based on applicable laboratory qualifiers and outcome of the data validation. Final data qualifiers are limited to and defined as follows.

U The analyte was analyzed for but was not detected above the reporting limit.

J The analyte was positively identified; the associated numerical value is an estimate of the concentration of the analyte in the sample.

UJ The analyte was not detected above the sample reporting limit. However, the reporting limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

N The identification of the compound is assumptive because the ion spectrum or dual column confirmation was not conclusive.

NJ The identification of the compound is assumptive and the reported value is considered estimated.

R The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

In cases of multiple analyses (such as an undiluted and a diluted analysis) performed on one sample, the optimal result will be determined and only the determined result is to be reported for the sample.

Results of the data validation will be documented and discussed in a data validation report (DVR) that will provide a basis for meaningful interpretation of the data quality and evaluate the need for corrective actions and/or a more extensive data quality investigation. The DVR shall be appended to the project report.

After the fieldwork and the final analytical data have been completed and reviewed, a data quality summary report (DQSR) will be prepared by the data QA officer. The report will summarize QA and audit information, including the results of the data review; evaluate field QC sample data, such as field duplicates; indicate any corrective actions taken; and describe overall compliance with the PMP, FSP, and this AQAP.

Proposed topics to be included in the data quality/usability summary report are:

- Investigation scope
- Investigation description
- Sampling procedures
- QC activities
- Analytical procedures
- Chemical data quality assessment (field duplicate results, detected analyte table, total results table(s), and rejected or qualified results table)
- Conclusions and recommendations

12.0 Performance and System Audits

Performance and systems audits may be conducted to determine whether:

- The QA program has been conducted and documented in accordance with specified requirements
- The documented program has been implemented
- Any nonconformance was identified and corrective actions were implemented.

The project manager will be responsible for seeing that the investigation performance satisfies the QA objectives as set forth in this FSP. The data QA officer will be responsible for initiating audits, selecting the audit team, and overseeing audit implementation.

The sediment technical lead will be responsible for supervising and ensuring that samples are collected and handled in accordance with the QAPP and that documentation of work is adequate and complete. Field performance will be evaluated using field duplicate samples.

Reports and technical correspondence will be peer reviewed by qualified individuals before being finalized.

12.1 Systems Audits

Technical systems audits are used to confirm the adequacy of the data collection (field operation) and data generation (laboratory operation) systems. The on-site audits are conducted to determine whether the investigation-specific plans and field and laboratory SOPs are being properly implemented. Systems audits of the field and laboratory procedures are not expected during this investigation. However, in the event that an on-site field audit is required, the audit procedures described in this section will be followed.

Internal systems audits of the laboratory will be performed when the laboratory QAM identifies the need, which may be throughout this investigation. An additional laboratory systems audit may be requested by the QAM, if warranted. The frequency of on-site audits will depend on the type of interaction and communications the QAM experiences with the laboratory staff, and on the frequency of observations of noncompliance with investigation-specific QC criteria and SOPs.

The laboratory QAM will regularly conduct the following internal audits:

- Technical audit, including reviews of calibration and equipment monitoring records, laboratory logbooks, maintenance records, and instrument control charts
- Data quality audit reviews, including all aspects of data collection, reporting, and review.

Management system audits, verifying that management and supervisory staff are effectively implementing and monitoring all QC activities necessary to support the laboratories' QA program.

12.2 Audit Procedure

This subsection provides requirements and guidance for performing internal and external audits, as required to verify compliance with the elements of the FSP.

The project manager and, if appropriate, other audited entity (e.g., sediment technical lead, project coordinator) will be notified by the QAM of an audit a reasonable time before the audit is performed.

This notification will be in writing and include information such as the general scope and schedule of the audit, and the name of the audit team leader.

A pre-audit conference will be conducted at the audit site with the appropriate manager or designated representative (e.g., sediment technical lead, laboratory project manager). The purpose of the conference will be to confirm the audit scope, present the audit plan, discuss the audit sequence, and plan for the post-audit conference.

The audit team will then implement the audit. Selected elements of the FSP will be audited to the depth necessary to evaluate the effectiveness of implementation. Checklists prepared by the audit team and approved by the QAM will be sufficiently detailed to document major audit components. Conditions requiring immediate corrective action will be reported immediately to the QAM.

At the conclusion of the audit, a post-audit conference will be held with the audited entities, or their designated representatives. The audit team leader will concisely state the audit findings and clarify any misunderstandings. The findings will be acknowledged by signature of the project manager or designated representative upon completion of the post-audit conference.

An audit report will be prepared by the audit team leader and signed by the QAM. The report will include the following:

- Description of the audit scope
- Identification of the audit team
- Persons contacted during pre-audit; audit; and post-audit activities
- A summary of audit results; including an evaluation statement regarding the effectiveness of the FSP elements that were audited
- Details of findings and program deficiencies
- Recommendations for corrective actions to the QAM; with a copy to the project manager and others as appropriate

12.3 Audit Response

The project manager and audited entities, or their designated representatives, will respond to an audit report within 7 days of receipt. The response will clearly state the corrective action for each finding, including action to prevent recurrence and the date the corrective action will be completed.

The QAM, upon receipt of the response, will take the actions described in Section 11.4 below.

12.4 Follow-Up Action

Follow-up action will be performed by the QAM or designated representative to:

- Evaluate the adequacy of the project manager or other audited entity’s response.
- Determine that corrective action is appropriate and scheduled for each finding.
- Confirm that corrective action has been accomplished as scheduled.

Follow-up action may be accomplished through written communications, re-audit, or other appropriate means. When all corrective actions have been verified, the QAM will send a memo to the project manager or other audited entity signifying the satisfactory closeout of the audit.

12.5 Audit Records

Original records generated for all audits will be retained in the central investigation files. Records will include audit reports, written responses, the record of completion of corrective actions, and documents associated with the conduct of audits that support audit findings and corrective actions as appropriate.

13.0 References

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Table AQAP-1. Project Personnel, Roles, Contact Information, and Specific Quality Assurance Responsibilities

Name	Role	Contact Information	Responsibilities
U.S. Environmental Protection Agency			
Helen Bottcher	Wyckoff/ Eagle Harbor Project Manager	US EPA Region 10, ms ECL-122 Office of Environmental Cleanup 1200 Sixth Avenue, Suite 900 Seattle, WA 98101 phone: (206) 553-6069 email: bottcher.helen@epa.gov	Provides oversight of all program activities. Reviews final project QA objectives, needs, problems, and requests. Approves appropriate QA corrective actions as needed.
Justine Barton	Sediment Technical Lead	US EPA Region 10, ms ETPA-088 1200 Sixth Avenue, Suite 900 Seattle, WA 98101-3140 phone (206) 553-6051 email: barton.justine@epa.gov	Assists in providing oversight of program activities. Reviews final project QA objectives, needs, problems, and requests.
Donald M. Brown	EPA Region 10 QA Officer	US EPA Region 10, ms OERA-140 1200 Sixth Avenue, Suite 900 Seattle, WA 98101 phone (206) 553-0717 email: brown.donaldm@epamail.epa.gov	EPA Region 10 QA Officer, provides oversight and concurrence for the review and approval of QAPP and laboratory QAP programs. Support EPA QA Manager, as needed, for project-specific oversight and approvals.
Don Matheny	EPA QA Manager	US EPA Region 10, ms OEA-095 1200 Sixth Avenue, Suite 900 Seattle, WA 98101-3140 phone (206) 553-2599 email: matheny.don@epa.gov	Reviews the QAPP and laboratory QAP (including SOPs) providing approval for laboratory analytical methods and procedures. Provides QA/QC support to the EPA RPM. Evaluates appropriate QA corrective actions.
U.S. Army Corps of Engineers, Seattle District			
Ellen Brown	Project Manager	U.S. Army Corps of Engineers Seattle District 4735 E Marginal Way S Seattle, WA 98134-2388 Phone: (206) 764-3536 email: Ellen.K.Brown@usace.army.mil	Provides oversight of all program activities. Reviews final project QA objectives, needs, problems, and requests. Approves appropriate QA corrective actions as needed. Provides liaison between contractor team and EPA.

Table AQAP-1. Project Personnel, Roles, Contact Information, and Specific Quality Assurance Responsibilities

Name	Role	Contact Information	Responsibilities
Marlowe Laubach	USACE QA Officer	U.S. Army Corps of Engineers Seattle District 4735 E Marginal Way S Seattle, WA 98134-2388 Phone: (206) 764-3524 email: Marlowe.D.Laubach@usace.army.mil	Reviews the QAPP and laboratory QAP (including SOPs) providing approval for laboratory analytical methods and procedures. Provides QA/QC support to the USACE Project Manager. Evaluates appropriate QA corrective actions.
Technical Contractor Team			
HDR Jeffrey Fellows	Project Manager	123 2nd Avenue, Suite 200 Edmonds, Washington 98020 Phone: (425) 245-9139 Email: Jeffrey.Fellows@hdrinc.com	Implements necessary actions and adjustments to accomplish program objectives. Oversees project performance and provides direction to accomplish project objectives. Ensures the project tasks are successfully completed within the projected time period. Maintains official copy of QAPP and all revisions. Administration, progress reporting, and invoice management.
HDR David Wolfe	Project QA Officer	3284 NE 42nd Street Carnation, WA 98014 (717) 503-5819 email: David.Wolfe@hdrinc.com	Provides senior technical QA support to the project work plan and reports.
HDR Kimberly Hawkins	Environmental Scientist	606 Columbia Street NW, Suite 200 Olympia, WA 98501 Phone: (360) 570-7266 Email: Kimberly.Hawkins@hdrinc.com	Assists the Project Manager to implement necessary action and adjustments to accomplish program objectives. Coordinates all facets of the project ensure completion in accordance with Work Plan.
HDR Colin Mills	Data Manager	1 International Boulevard 10th Floor Suite 1000 Mahwah, NJ 07495 Phone (201) 335-9404 Email: Colin.Mills@hdrinc.com	Performs input of field data and management of electronic data deliverable to meet project requirements for field database. Works closely with the Sediment Technical Lead. Manages to ensure the completeness and correctness of the field data deliverables.

Table AQAP-1. Project Personnel, Roles, Contact Information, and Specific Quality Assurance Responsibilities

Name	Role	Contact Information	Responsibilities
HDR Lynn Lutz	Data QA Officer	9781 S. Meridian Boulevard, Suite 400 Englewood, CO 80112 Phone: (303) 754-4266 email: Lynn.Lutz@hdrinc.com	Reviews and approves the AQAP. Reviews and approves laboratory QAP (including SOPs) for the project. Provides technical QA assistance to accomplish project objectives, including suggestions for corrective action implementation. Provides chemical data verification and validation and ensures validated chemical data are entered into the database.
SEE Tim Thompson	Sediment Technical Lead Field H&S Officer	4401 Latona Avenue NE Seattle, WA 98105 Phone: (206) 418-6173 email: tthompson@seellc.com	Prepares the FSP and assists in preparing the AQAP associated with the sediment sampling. Serves as Field Manager in conducting the sediment sampling in compliance with the FSP and QAPP. Supervises implementation of standard operating procedures, health and safety procedures, project modifications, and corrective actions during field operations. Serves as Sediment Site Health and Safety Officer. Ensures core logs are entered into the database. Prepares the draft and final monitoring report and recommendations for future actions.
SEE David Browning	Senior Sediment Scientist	5541 Keating Road NW Olympia, WA 98502 Phone: (360) 866-6806 email: david_browning@comcast.net	Assists in the preparation of FSP and AQAP. Conducts the sediment sampling in compliance with the FSP and QAPP at the direction of the Field Manager. Prepares the draft and final monitoring report.
MCA Maps Jeffrey Kenner	Surveying Team Project Manager	19550 International Boulevard, Ste 203 Seatac, WA 98188 Phone: (206) 512.0301 email: jeffrey.kenner@mcamaps.com	Oversees project performance, management, and reporting of survey team. Manages and implements topographical survey. Support data exchange and final survey data reporting.
Laboratory Analyses			
ARI Cheronne Oreiro	Laboratory Project Manager	4611 S 134th Place # 100 Tukwila, WA 98168-3212 Phone: (206) 695-6214 email: cheronne@arilabs.com	Responsible for the analysis of sediment chemistry parameters. Ensures implementation of the project and laboratory QA plans, reports to KTA Data QA Officer, and serves as the laboratory point of contact.

Table AQAP-1. Project Personnel, Roles, Contact Information, and Specific Quality Assurance Responsibilities

Name	Role	Contact Information	Responsibilities
EPA Manchester Laboratory Gerald Dodo	Analytical Project Manager Clam Tissue Analyses	7411 Beach Drive East Manchester, WA 98353 Phone: (360) 871-8728 email: dodo.gerald@epa.gov	Responsible for chemical analyses of clam tissue samples. Ensures implementation of the USACE QAPP for clam tissue analyses, and reports through the EPA RPM to the USACE Technical Lead.

Table AQAP- 2. Sample Types, Sample Matrix, Number of Surface and Core Samples, and Sample Analyses

Associated Field and Analytical Actions	Sample Numbers		Conventionals (TOC, Total Solids)	Grain Size	PCP by 8041	PAHs by 8270 SIM	Mercury
Subtidal Cap	**Surface Sediment**	**Cores Number**					
Surface Samples within grids J9 and J10. • Two (2) composite samples • Three sub-grid stations sampled and composited for each parent grid. • Analyze for conventionals, grain size, PAHs, PCP, and mercury.	2	---	2	2	2	2	2
Exposure Barrier System and West Beach							
West Beach Exposure Barrier Surface Sediment Samples • Six (6) composite samples • Three (3) 2011 OMMP locations, two (2) in-field designated, and one (1) West Beach station • Three sub-grid stations sampled and composited for each parent grid. • Analyze for conventionals, grain size, PAHs, and PCP.	6	---	6	6	6	6	---
North Shoal Subtidal Area							
North Shoal Sediment Cores • Five (5) coring locations in grids J7, K7, J8, K8, and L8. • Cores collected and logged to 6-ft below mud line • No chemical analyses on collected cores	---	5	---	---	---	---	---
North Shoal Subtidal Surface Sediment Samples • Five (5) composite samples from grids J7, K7, J8, K8, and L8. • Three sub-grid stations sampled and composited for each parent grid. • Analyze for conventionals, grain size, PAHs, PCP, and mercury.	5	---	5	5	5	5	5
Totals	**13**	**5**	**13**	**13**	**13**	**13**	**7**

Table AQAP-3. Remedial Goals for Intertidal and Subtidal Sediment and Laboratory LODs and LOQs

Analyte	Laboratory LOD/LOQ (mg/kg)		Intertidal Sediment, Method B, Carcinogen, Direct Contact (ingestion only), unrestricted land use[A] (mg/kg)	Intertidal Sediment Method B, Non-carcinogen, Direct Contact (ingestion only), unrestricted land use (mg/kg)	Subtidal and Intertidal Sediment MCUL[C] (mg/kg OC)	Subtidal and Intertidal Sediment 2LAET [C] (mg/kg -dry) Used at and below 0.5% OC.	ROD Intertidal Sediment, Human Health (mg/kg)
	LOD	LOQ					
Total LPAH			--	370	780	5.2	--
Anthracene	0.0025	0.005	--	24,000	1,200	0.96	--
Acenaphthylene	0.0025	0.005	--	--	66	1.3	--
Acenaphthene	0.0025	0.005	--	4,800	57	0.5	--
Fluorene	0.0025	0.005	--	3,200	79	0.54	--
Phenanthrene	0.0025	0.005	--	--	480	1.5	--
Methyl naphthalene;1-	0.0025	0.005	--	24	--	--	--
Methyl naphthalene;2-	0.0025	0.005	--	320	64	0.67	--
Naphthalene	0.005	0.005	--	1,600	170	2.1	--
Total HPAH			--	--	5,300	17	1.2
Indeno (1,2,3,-c,d)pyrene	0.004	0.005	0.14	--	88	0.69	--
Dibenzo (a,h)anthracene	0.004	0.005	0.14	--	33	0.23	--
Benzo(g,h,i)perylene	0.004	0.005	--	--	78	--	--
Benzo[a]anthracene	0.0025	0.005	0.14	--	270	1.6	--
Benzo[a]pyrene	0.0025	0.005	0.14	--	210	1.6	--
Benzo[b]fluoranthene	0.0025	0.005	0.14	--	--	--	--
Benzo[k]fluoranthene	0.0025	0.005	0.14	--	--	--	--
Total Benzofluoranthenes	0.005	0.01	--		450	3.6	--
Chrysene	0.0025	0.005	0.14	--	460	2.8	--
Pyrene	0.004	0.005	--	2,400	1,400	3.3	--
Fluoranthene	0.004	0.005	--	3,200	1,200	2.5	--
Total PAH			1.4[B]	--	--	--	--
Pentachlorophenol	0.00313	0.00625	8.3	--	690	0.69	--

[A] - The values shown are from the 2007 ESD and are individually at 1E-06 incremental lifetime cancers

[B] - Sum of Benzo(a)pyrene toxicity equivalents are not to exceed 1E-05 incremental lifetime cancers.

[C] - Sediment Management Standards MCUL expressed as mg/kg organic carbon; and 2LAET second Lowest Apparent Effects Threshold expressed as mg/kg dry weight .

LOD - Limit of Detection

LOQ - Limit of Quantitation

mg/kg - milligram per kilogram

Table AQAP-4. Sediment Management Standards, LODs, and LOQs for Sediments

Analytes	Analytical Method	CAS #	Laboratory LODs/LOQs		Sediment Management Standards	
			LODs	LOQs	SQS	CSL
Conventional Inorganic Parameters			(%)			
Total Organic Carbon	Plumb, 1981	-	0.02	0.02	-	-
Grain Size	PSEP	-	0.10%	0.10%	-	-
Total Solids	SM2540G		0.10%	0.10%	-	-
Metals			(mg/kg)		(mg/kg)	
Mercury	SW7471A	7439-97-6	0.0013	0.025	0.41	0.59
Organic Compounds						
Polycyclic Aromatic Hydrocarbons			(μg/kg)		(mg/kg OC)	
Total LPAH	SW8270D-SIM	-	-	-	370	780
Anthracene	SW8270D-SIM	120-12-7	2.5	5.0	220	1,200
Acenaphthylene	SW8270D-SIM	208-96-8	2.5	5.0	66	66
Acenaphthene	SW8270D-SIM	83-32-9	2.5	5.0	16	57
Fluorene	SW8270D-SIM	86-73-7	2.5	5.0	23	79
Phenanthrene	SW8270D-SIM	85-01-8	2.5	5.0	100	480
2-Methylnaphthalene	SW8270D-SIM	91-57-6	2.5	5.0	38	64
Naphthalene	SW8270D-SIM	91-20-3	5.0	5.0	99	170
Total HPAH	SW8270D-SIM	-	-	-	960	5,300
Indeno(1,2,3-cd)pyrene	SW8270D-SIM	193-39-5	4.0	5.0	34	88
Dibenz(a,h)anthracene	SW8270D-SIM	53-70-3	4.0	5.0	12	33
Benzo(g,h,i)perylene	SW8270D-SIM	191-24-2	4.0	5.0	31	78
Benzo(a)anthracene	SW8270D-SIM	56-55-3	2.5	5.0	110	270
Benzo(a)pyrene	SW8270D-SIM	50-32-8	2.5	5.0	99	210
Benzo(b)fluoranthene[A]	SW8270D-SIM	205-99-2	2.5	5.0	-	-
Benzo(k)fluoranthene[A]	SW8270D-SIM	207-08-9	2.5	5.0	-	-

Table AQAP-4. Sediment Management Standards, LODs, and LOQs for Sediments

Analytes	Analytical Method	CAS #	Laboratory LODs/LOQs		Sediment Management Standards	
			LODs	LOQs	SQS	CSL
Total Benzofluoranthene	SW8270D-SIM	-	5.0	10.0	230	450
Chrysene	SW8270D-SIM	218-01-9	2.5	5.0	110	460
Pyrene	SW8270D-SIM	129-00-0	4.0	5.0	1,000	1,400
Fluoranthene	SW8270D-SIM	206-44-0	4.0	5.0	160	1,200
Phenols and Substituted Phenols			**(µg/kg)**		**(µg/kg)**	
Pentachlorophenol	SW8041	87-86-5	3.13	6.25	360	690

Notes:

[A] Benzo(b)fluoranthene and benzo(k)fluoranthene co-elute

mg/kg = milligram per kilogram

µg/kg = microgram per kilogram

mg/kg OC = milligram per kilogram organic carbon normalized

CAS - Chemical Abstract System

CSL - Cleanup Screening Level

SIM - Selective Ion Monitoring

SQS - Sediment Quality Standard

Table AQAP-5. Sample Preparation and Analysis Methods for Sediment and Water Samples

Analyte	Preparation Method	Procedure	Analytical Method	Technique
Sediment Samples				
Total Organic Carbon	Plumb 1981	Acid pretreatment	Plumb et al., 1981	Combustion; coulometric titration
Grain Size	PSEP 1986	Oven dry	PSEP 1986	Sieves and pipette
Total Solids	SM2540G	Oven dry	SM2540G	Gravimetric
PAHs	SW3546	Microwave extraction	SW8270D-SIM	GC/MS
PCP	SW3550C	Ultrasonic extraction Gel permeation chromatography	SW8041	GC/MS and GC
Mercury	SW7471A	Potassium permanganate oxidation	SW7471A	CVAAS
Water Samples				
PAHs	SW3520C	Continuous liquid-liquid extraction	SW8270D-SIM	GC/MS-SIM
PCP	SW3510C	SepFunnel extraction	SW8041	GC/MS and GC
Mercury	SW7470A	Potassium permanganate oxidation	SW7470A	CVAAS

Notes:

All methods cited herein are based on EPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Third Edition, unless otherwise noted.

CVAAS: cold vapor atomic absorption spectrometry

GC/MS: gas chromatography/mass spectrometry

PAHs: polycyclic aromatic hydrocarbons

PCP: pentachlorophenol

PSEP: Puget Sound Estuary Program

SIM: selective ion monitoring

Table AQAP-6. Accuracy and Precision Control Limits for PAHs in Sediments

Analyte	CAS#	Surrogate Spike %R	LCS & MS %R (%)	RPD (%)
1-Methylnaphthalene	90-12-0		39-120	≤ 30
2-Methylnaphthalene	91-57-6		35-120	≤ 30
Acenaphthene	83-32-9		39-120	≤ 30
Acenaphthylene	208-96-8		35-120	≤ 30
Anthracene	120-12-7		36-120	≤ 30
Benzo(a)anthracene	56-55-3		42-120	≤ 30
Benzo(a)pyrene	50-32-8		36-120	≤ 30
Benzo(b)fluoranthene	205-99-2		35-127	≤ 30
Benzo(k)fluoranthene	207-08-9		37-129	≤ 30
Benzofluoranthene(s) (Total)	-		46-120	≤ 30
Chrysene	218-01-9		48-120	≤ 30
Dibenz(a,h)anthracene	53-70-3		38-120	≤ 30
Dibenzofuran	132-64-9		38-120	≤ 30
Fluoranthene	206-44-0		46-120	≤ 30
Fluorene	86-73-7		41-120	≤ 30
Indeno(1,2,3-c,d)pyrene	193-39-5		40-120	≤ 30
Naphthalene	91-20-3		36-120	≤ 30
Pentachlorophenol	87-86-5		56-120	≤ 30
Phenanthrene	85-01-8		46-120	≤ 30
Pyrene	129-00-0		49-120	≤ 30
2-Methylnaphthalene-d_{10}	7297-45-2	32-120		≤ 40
Dibenzo(a,h)anthracene-d_{14}	13250-98-1	21-133		≤ 40
Fluoranthene-d_{10}	93951-69-0	36-134		
2,4,6-Tribromophenol	118-79-6	10-129		

Notes:

(1) Detection Limit (DL) as defined in ARI SOP 1018S

(2) Limit of Detection (LOD) as defined in ARI SOP 1018S

(3) Limit of Quantitation (LOQ) as defined in ARI SOP 1018S

(4) Highlighted control limits (**bold font**) are adjusted from the calculated values to reflect that ARI does not use control limits < 10 for the lower limit or < 100 for the upper limit.

(5) Control limits calculated using all data from 1/1/08 through 12/31/08.

(6) Relative Percent Difference between analytes in replicate analyzes.

LCS - Laboratory control sample

MS - Matrix spike

%R - Percent recovery

RPD - Relative percent difference

Table AQAP-7. Accuracy and Precision Control Criteria for SMS Chemicals in Sediments

Analyte	Analytical Method	Surrogate Spike Accuracy [1] (% Rec.) [2]	LCS Accuracy (% Rec.)	Matrix Spike (% Rec.)	Precision (RPD)
Conventional Inorganic Parameters					
Solids, Total	SM2540G		NA	NA	≤20
Total Organic Carbon	Plumb 1981		80-120	75-125	≤20
Grain Size	PSEP		NA	NA	≤20
Metals					
Mercury	SW7471A		80-120	75-125	≤20
Organic Compounds					
PAHs					
2-Methylnaphthalene	SW8270D-SIM		35-120	35-120	≤ 30
Acenaphthene	SW8270D-SIM		39-120	39-120	≤ 30
Acenaphthylene	SW8270D-SIM		35-120	35-120	≤ 30
Anthracene	SW8270D-SIM		36-120	36-120	≤ 30
Benzo(a)anthracene	SW8270D-SIM		42-120	42-120	≤ 30
Benzo(a)pyrene	SW8270D-SIM		36-120	36-120	≤ 30
Benzo(b)fluoranthene	SW8270D-SIM		35-127	35-127	≤ 30
Benzo(g,h,i)perylene	SW8270D-SIM		38-120	38-120	≤ 30
Benzo(k)fluoranthene	SW8270D-SIM		37-129	37-129	≤ 30
Chrysene	SW8270D-SIM		48-120	48-120	≤ 30
Dibenz(a,h)anthracene	SW8270D-SIM		38-120	38-120	≤ 30
Dibenzofuran	SW8270D-SIM		38-120	38-120	≤ 30
Fluoranthene	SW8270D-SIM		46-120	46-120	≤ 30
Fluorene	SW8270D-SIM		41-120	41-120	≤ 30
Indeno(1,2,3-cd)pyrene	SW8270D-SIM		40-120	40-120	≤ 30
Naphthalene	SW8270D-SIM		36-120	36-120	≤ 30
Phenanthrene	SW8270D-SIM		46-120	46-120	≤ 30
Pyrene	SW8270D-SIM		49-120	49-120	≤ 30
2-Methylnaphthalene-d10	7297-45-2	32-120			
Dibenzo(a,h)anthracene-d14	13250-98-1	21-133			
Fluoranthene-d10	93951-69-0	36-134			
PCP					
Pentachlorophenol	SW8041		56-120	56-120	≤ 30
2,4,6-Tribromophenol	118-79-6	10-129			

Notes:
(1) Listed surrogate spike, precision, and accuracy control limits based on in-house performance statistics of Analytical Resources Inc.
The values are subject to change as the laboratory is updating the control limits per EPA requirements.
(2) % Rec. = Percent recovery

Table AQAP-8. LODs, LOQs, and Accuracy and Precision Control Limits for PAHs in Water

Analyte	CAS#	LOD[1] (µg/L)	LOQ[2] (µg/L)	Surrogate Spike %R	LCS & MS %R[3] (%)	RPD[4] (%)
1-Methylnaphthalene	90-12-0	0.05	0.1		37-120	≤ 30
2-Methylnaphthalene	91-57-6	0.05	0.1		29-120	≤ 30
Acenaphthene	83-32-9	0.05	0.1		38-120	≤ 30
Acenaphthylene	208-96-8	0.05	0.1		32-120	≤ 30
Anthracene	120-12-7	0.05	0.1		39-120	≤ 30
Benzo(a)anthracene	56-55-3	0.05	0.1		37-120	≤ 30
Benzo(a)pyrene	50-32-8	0.05	0.1		25-120	≤ 30
Benzo(b)fluoranthene	205-99-2	0.05	0.1		38-128	≤ 30
Benzo(k)fluoranthene	207-08-9	0.05	0.1		36-130	≤ 30
Benzofluoranthene(s) (Total)	-	0.1	0.2		46-120	≤ 30
Chrysene	218-01-9	0.05	0.1		55 – 114	≤ 30
Dibenz(a,h)anthracene	53-70-3	0.075	0.1		48-120	≤ 30
Dibenzofuran	132-64-9	0.05	0.1		38-12	≤ 30
Fluoranthene	206-44-0	0.05	0.1		48-120	≤ 30
Fluorene	86-73-7	0.05	0.1		41-120	≤ 30
Indeno(1,2,3-c,d)pyrene	193-39-5	0.05	0.1		32-120	≤ 30
Naphthalene	91-20-3	0.05	0.1		33-120	≤ 30
Pentachlorophenol	87-86-5	0.16	0.25		48-120	≤ 30
Phenanthrene	85-01-8	0.05	0.1		49-120	≤ 30
Pyrene	129-00-0	0.05	0.1		48-120	≤ 30
2-Methylnaphthalene-d_{10}	7297-45-2			31-120		
Dibenzo(a,h)anthracene-d_{14}	13250-98-1			10-125		
Fluoranthene-d_{10}	93951-69-0			46-121		
2,4,6-Tribromophenol	118-79-6			26-120		

Notes:

(1) Limit of Detection (LOD) as defined in ARI SOP 1018S

(2) Limit of Quantitation (LOQ) as defined in ARI SOP 1018S

(3) Control limits calculated using all data from 1/1/08 through 12/31/08.

(4) Relative Percent Difference between analytes in replicate analyzes.

LCS - Laboratory control sample

MS - Matrix spike

%R - Percent recovery

RPD - Relative percent difference

µg/L - Microgram per liter

Table AQAP-9. LODs, LOQs, and Accuracy and Precision Control Criteria for SMS Chemicals in Water

Analyte	Analytical Method	LOD	LOQ	Surrogate Spike Accuracy [1](% Rec.)	LCS Accuracy (% Rec.)	Matrix Spike (% Rec.)	Precision (RPD)
Metals		**µg/L**					
Mercury	SW7470A	0.0026	0.02		80-120	75-125	≤20
Organic Compounds							
PAHs		***µg/L***					
1-Methylnaphthalene	SW8270D-SIM	0.05	0.1		37-120	37-120	≤30
2-Methylnaphthalene	SW8270D-SIM	0.05	0.1		29-120	29-120	≤30
Acenaphthene	SW8270D-SIM	0.05	0.1		38-120	38-120	≤30
Acenaphthylene	SW8270D-SIM	0.05	0.1		32-120	32-120	≤30
Anthracene	SW8270D-SIM	0.05	0.1		39-120	39-120	≤30
Benzo(a)anthracene	SW8270D-SIM	0.05	0.1		37-120	37-120	≤30
Benzo(a)pyrene	SW8270D-SIM	0.05	0.1		25-120	25-120	≤30
Benzo(b)fluoranthene[A]	SW8270D-SIM	0.05	0.1		38-128	38-128	≤30
Benzo(g,h,i)perylene	SW8270D-SIM	0.05	0.1		21-120	21-120	≤30
Benzo(k)fluoranthene[A]	SW8270D-SIM	0.05	0.1		46-120	46-120	≤30
Chrysene	SW8270D-SIM	0.05	0.1		55 – 114	55 – 114	≤30
Dibenz(a,h)anthracene	SW8270D-SIM	0.075	0.1		48-120	48-120	≤30
Dibenzofuran	SW8270D-SIM	0.05	0.1		38-12	38-12	≤30
Fluoranthene	SW8270D-SIM	0.05	0.1		48-120	48-120	≤30
Fluorene	SW8270D-SIM	0.05	0.1		41-120	41-120	≤30
Indeno(1,2,3-cd)pyrene	SW8270D-SIM	0.05	0.1		32-120	32-120	≤30
Naphthalene	SW8270D-SIM	0.05	0.1		33-120	33-120	≤30
Phenanthrene	SW8270D-SIM	0.05	0.1		49-120	49-120	≤30
Pyrene	SW8270D-SIM	0.05	0.1		48-120	48-120	≤30
2-Methylnaphthalene-d10	7297-45-2			31-120			
Dibenzo(a,h)anthracene-d14	13250-98-1			10-125			
Fluoranthene-d10	93951-69-0			46-121			

Table AQAP-9. LODs, LOQs, and Accuracy and Precision Control Criteria for SMS Chemicals in Water

Analyte	Analytical Method	LOD	LOQ	Surrogate Spike Accuracy [1](% Rec.)	LCS Accuracy (% Rec.)	Matrix Spike (% Rec.)	Precision (RPD)
PCP							
Pentachlorophenol	SW8041	0.13	0.25		48-120	48-120	≤30
2,4,6-Tribromophenol	118-79-6			26-120			

Notes:

(1) Listed surrogate spike, precision, and accuracy control limits based on in-house performance statistics of Analytical Resources Inc. The values are subject to change as the laboratory is updating the control limits per EPA requirements.

[A] Benzo(b)fluoranthene and benzo(k)fluoranthene co-elute

Highlighted control limits (**bold font**) are adjusted from the calculated values to reflect that ARI does not use control limits < 10 for the lower limit or < 100 for the upper limit.

%REC = Percent recovery

LOD = Limit of detection

LOQ = Limit of Quantitation

Table AQAP-10. Sample Type, Container, Holding Times, Preservatives, and Storage Requirements

Parameter	Minimum Sample Size[1]	Container Description	Preservation Requirements	Holding Time
Sediment Samples				
Grain size	100 g	16-oz glass or HDPE	4°C ±2°C	6 months
TOC	25 g	4-oz glass	4°C ±2°C -20°C ±2°C	14 days 6 months
Total Solids	50 g		4°C ±2°C -20°C ±2°C	14 days 6 months
Mercury [2]	1 g	4-oz glass	4°C ±2°C -20°C ±2°C	28 days 1 years
PAHs and PCP	200 g	8-oz glass	4°C ±2°C -20°C ±2°C	14 days 1 year
Archive	1000 g	16-oz glass	-20°C ±2°C	6 months
Water Samples				
Mercury	10 mL	500ml HDPE	HNO3, 4°C ±2°C	28 days
PAHs and PCP	500 mL	4 x 500 mL Amber glass	4°C ±2°C	7 days

Notes:
1. Recommended minimum field sample sizes for one laboratory analysis. Actual volumes to be collected have been increased to provide a margin of error and allow for retests.
2. During transport to the lab, samples will be stored on ice. The mercury sample will either be analyzed immediately or frozen upon receipt at the laboratory. The archived samples will be frozen immediately upon receipt at the lab.

HDPE - high density polyethylene

PAHs - polycyclic aromatic hydrocarbons

PCP - pentachlorophenol

TOC - total organic carbon

Table AQAP-11. Field Quality Control Sample Requirements

Field Groups and Associated QA/QC	Sample Numbers		Conventionals (TOC, Total Solids)	Grain Size	PAHs by 8270-SIM	PCP by 8041	Mercury
	Surface Sediment	Cores Number					
Exposure Barrier System and West Beach							
Field Replicates (5%)	---	6	1	1	1	1	---
MS/MSD (5%)			1	1	1	1	---
Water - Equipment Rinsate (5%)			1	1	1	1	---
Subtidal Cap and North Shoal Subtidal Surface Sediment Samples							
Field Replicates (5%)	7	---	1	1	1	1	1
MS/MSD (5%)			1	1	1	1	1
Water - Equipment Rinsate (5%)			1	1	1	1	1

Table AQAP-12. Laboratory QA Sample Requirements

Analysis Type	Method Blanks	Triplicates[1]	Replicates[2]	SRM[3]	Matrix Spike[1]	Surrogates[4]
Polycyclic Aromatic Hydrocarbons	**P**[5]		**P**[6]	**P**	**P**	**P**
PCP	**P**[5]		**P**[6]		**P**	**P**
Mercury	**P**[1]		**P**[1]	**P**	**P**	
Total Organic Carbon	**P**[1]	**P**		**P**		
Total Solids		**P**				
Grain Size		**P**				

Notes:

[1]Frequency of Analysis (FOA) = 5% or one per batch, whichever is more frequent

[2]Matrix spike duplicate analysis to be performed in lieu of replicate

[3]Standard Reference Material

[4]Surrogate spikes required for every sample, including matrix spiked samples, blanks, and reference materials

[5]FOA = one per extraction batch

[6]FOA = <20 samples: one per batch; 20+ samples: 1 triplicate and additional duplicates for a minimum of 5% total replication

PCP = Pentachlorophenol

Table AQAP-13. Parameters Used to Evaluate Data Quality

Data Quality Indicators	QC Parameters
Precision	RPD values of:
	(1) LCS/LCS Duplicate
	(2) MS/MSD
	(3) Field Duplicates
Accuracy/Bias	Percent Recovery (%R) or Percent Difference (%D) values of:
	(1) Initial Calibration and Calibration Verification
	(2) LCS
	(3) MS
	(4) Surrogate Spikes
	Results of:
	(1) Instrument and Calibration Blank
	(2) Method (Preparation) Blank
	(3) Trip Blank
	(4) Equipment Rinsate Blank
Representativeness	Results of All Blanks
	Sample Integrity (CoC and Sample Receipt Forms)
	Holding Times
	Total vs. Dissolved Metals Correlation
Comparability	Sample-specific LOQs
	Sample Collection Methods
	Laboratory Analytical Methods
Completeness	Data qualifiers
	Laboratory deliverables
	Requested/Reported valid results
Sensitivity	LODs and LOQs

Table AQAP-14. Data Quality Review Responsibilities

Task	Laboratory	Project Chemist	Project Manager
Laboratory review of preliminary data quality and data reduction	X		
Independent review of preliminary data		X	X
Laboratory review of final data quality	X		
Data evaluation and validation		X	
Data validation report and data quality summary report		X	

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